New Curricula

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EDITED BY **ROBERT W. HEATH**

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NEW CURRICULA

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Preface

The new curricula that have appeared during the last few years have stimulated considerable interest, some controversy, and probably some confusion. A distinctive characteristic of these new courses is that they have not been initiated by local and state educational authorities. The sponsors of these new courses have received their financial support from government agencies and private philanthropic foundations. Because of the variety of subjects, administrative structures, methods, and titles, the similarities and differences among these curricula have not been self-evident.

One purpose of this book is to provide a description of the goals, history, and status of several key curriculum projects in the words of people closely associated with their direction (Chapters 2, 3, 5, 6, 7, 9, 10, and 11). A second purpose is to gather together for the reader discussions of the implications of these courses for a variety of educational issues (Chapters 1, 4, 8, 12, 13, and 14). This volume is not intended as a descriptive catalog of current curriculum projects. Two recent publications serve that purpose well: *Current Curriculum Studies in Academic Subjects* by Dorothy M. Fraser, published by the National Education Association in June, 1962 and *Science Course Improvement Projects,* prepared by the National Science Foundation's Course Content Improvement Section in October, 1962.

Five of the fourteen chapters that follow are reprinted from earlier publications. References to dates in these chapters reflect the time that the original article was written, rather than the publication date of this anthology. I am grateful to their authors and publishers for permission to include these writings in this book. Specific acknowledgments will be found on the first pages of these selections. Dan C. Pinck, Secretary of the Committee on Curriculum Content Planning

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R.W.H.

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NEW CURRICULA

1

Introduction

PAUL WOODRING · SATURDAY REVIEW EDUCATION SUPPLEMENT AND WESTERN WASHINGTON STATE COLLEGE

The curricular revisions described in this book are a part of a new reform movement in education which gives promise of bringing sweeping changes in all the schools from kindergarten through the university. This movement had its origins in the years following World War II when critics of the status quo in the public school found a large and receptive audience among troubled and discouraged parents who doubted that the schools were doing all they could do and ought to do for their children. It was augmented by academic scholars troubled by what they perceived to be a decline of standards and an outmoded curriculum in the high school. It was given impetus by international threats and by the launching of Sputnik I and the debate that followed. And, by 1960, it was supported by a growing number of professional educators who had become convinced that a new look was needed in American education.

Although it does not yet have a name, and hence is not easily identified or clearly perceived, the new reform movement is already well established and growing vigorously. It has many facets. It includes a new emphasis on greater rigor and higher standards and a move away from such individual goals as "life adjustment" and toward broader goals that will make possible the survival of the nation and the expansion and further development of the culture. It makes use of new technological developments such as educational television and teaching machines and the programmed learning that goes into them. It includes programs for the reallotment of the variables of time, space, and personnel in the schools and provides for team teaching and for regrouping of children to facilitate learning. It places less emphasis on social and recreational activities and more emphasis on intellectual development. It includes new programs for teacher education such as the MAT programs which prepare high school teachers firmly grounded in their academic disciplines. And it incorporates all the new programs for curricular revision such as are included in this volume. These various facets are not yet closely interrelated and many educators do not yet perceive them as part of the same pattern, but it seems probable that the educational historians of the future will report them all as a part of the great educational reform movement of the sixties and seventies.

Curricular reform is long overdue. In the natural sciences the vast expansion of knowledge of recent years is not yet reflected in conventional courses in physics, chemistry, and biology. Mathematics has undergone profound changes which do not appear in most of the textbooks. A great gulf has developed between the "social studies" taught in the high schools and the "social sciences" taught in the colleges, which needs to be closed. New and improved techniques are now available for the teaching of foreign languages but many schools make no use of them. Even if all the proposed reforms continue to expand at the present speed it will take a decade or more for the school curriculum to catch up with the fast moving events on the frontiers of knowledge. Clearly the time has come for an educational revolution.

Changes in the schools do not proceed at a steady pace. Educational reform, like all social reform, comes in waves, with long periods between the waves in which the reforms are re-examined, re-evaluated, and sometimes modified or rejected. The reforms most vivid in the memory of living educators are those loosely grouped together under the term "progressive education." This reform movement had its origins in the nineteenth century (or possibly with Rousseau in the eighteenth) but it reached its crest during the years between 1918 and 1938. The great majority of American public schools never accepted progressivism to a degree satisfactory to progressive leaders but all of them felt its impact and were, in many subtle ways, influenced by it.

Progressive education rested in part upon new or revised philosophical assumptions about the nature of man and the nature of the good society that had developed during the nineteenth century, but it also borrowed freely from the psychological evidence regarding the nature of motivation and of learning, and the nature and extent of individual differences which accumulated rapidly during the first third of the twentieth century.

In contrast to the educational philosophies it superseded, progressivism placed much greater emphasis on the processes of education and less on the content or subject matter to be taught. Progressives were fond of saying, "We do not teach subjects, we teach children."

When the progressive educators became influential, in the nineteen-twenties, the high school curriculum had a heavy subject-matter emphasis not to their liking. The content of the academic courses required of those preparing for college had been stabilized early in the century when much of the course content was determined by the college professors of the day who wrote most of the high school texts. The required sequence included algebra, plane and solid geometry, European and American history, English and American literature, usually a choice of biology or physics and chemistry, and a foreign language. The geometry, of course, was Euclidean and the physics Newtonian. The history was largely political and military, and the literature included selections from Shakespeare—usually Macbeth and Hamlet—English poets, and a few novelists, plus selections from those American writers who were held in highest respect at the turn of the century—Longfellow and Whittier were given preference over Whitman and Poe, and Hawthorne was more likely to be read than Melville. Latin stressed formal grammar during the first high school year and students read Caesar's Gallic Wars in the second.

Professional educators, under the influence of progressive philosophies, were convinced that the traditional curriculum, organized along subject matter lines, did not meet the needs of children. As an alternative they proposed an "experience curriculum" consisting of projects through which the child might learn the things he needed to know and such skills as reading, writing, and spelling, as by-products of enjoyable activities planned by the children themselves. In such activities the child, it was believed, would be more highly motivated, and would learn to participate cooperatively as a member of a group, and would develop a healthy, outgoing personality free of the frustrations experienced by many children who learned history, English, mathematics, or science through the traditional classroom procedures.

The project method came into prominence in the 1920's and achieved its greatest acceptance in the elementary schools. At the secondary level the curriculum changed more slowly but in the rapidly growing junior high schools the core curriculum, which cut across subject matter lines and provided larger blocks of time in place of short periods devoted to a single subject, became a common practice.

The traditional textbooks, written in many cases by university professors and each restricted to a single academic discipline, were not easily adapted to these new programs. Partly because of this fact, and partly because the older textbooks were found to be too difficult for an increasing number of students of low academic talent who now were entering the secondary schools and whom the high schools were now required to retain at least until the age of sixteen, professional educators began writing their own textbooks. Many of the books were written by teams which consisted of a subject matter specialist, a curriculum specialist, and a professional writer with a background in professional education who was selected for his knowledge of the vocabularies and reading comprehension levels of children of some given age. Often the textbooks were completely rewritten in the editorial offices of the publishing house.

The textbooks produced in this way differed greatly from those written by a single academic scholar. They were physically more attractive, with better illustrations and more readable type. Their vocabularies were carefully tailored to a pre-established mental age level. They were more informal and chatty. They demanded much less of the student. And, because they ignored the restrictions of subject matter lines, they gave the student less understanding of the separate academic subjects as intellectual disciplines. For the majority of public school students, whose formal education was to terminate when they reached the age of 16 or 18 this created no problem but for those who went on to college it did.

College professors have always complained that the students coming to them were unprepared for college work but during the 1950's the complaints became a crescendo. The new curricula, the new textbooks, and the view of education held by professional educators —particularly the view that the curriculum should be based upon the child's "felt needs," came under sharp attack.

Educators countered with the evidence from the "Eight Year Study" that students graduating from experimental high schools did as well in college as those from traditional high schools but the evidence was susceptible to various interpretations and did not satisfy the critics.

The curricular revisions of the present day represent, to some extent, a return to the older tradition that dominated the secondary schools before the progressive revolution. It is true that the content is new but once again the emphasis is on subject matter organized within the separate academic disciplines. Once again university scholars and scientists are playing a large part in deciding what is to be taught in the secondary schools and the part played by those professional educators, whose graduate degrees are in education rather than in an academic discipline has been correspondingly reduced in importance. It is true that most of the new curriculum committees include secondary school teachers but, in most cases, these have been carefully selected on the basis of a firm grounding in an academic discipline and demonstrated success as teachers rather than for their professional education.

In the chapters that follow the term "curriculum revision" seems to mean the preparation of new and improved educational materials: textbooks, supplementary readings, visual aids, laboratory equipment, and examinations for use in the classroom. This concept of the curriculum represents a departure from the approach most popular during the twenties, thirties, and forties, when the view was widely accepted that a curriculum was the total experience of the child and that what took place outside the formal school setting was no less important than what took place in the classroom.

It is hardly surprising that the new curricula are regarded sceptically by many of today's "curriculum specialists" who gained their positions in the schools, not as a result of deep involvement in a single academic discipline but through graduate work in professional courses leading to a master's or doctor's degree in education. The new curricula, if accepted in the schools, will take the responsibility for curriculum making out of the hands of such curriculum specialists and reduce the importance of their role as policy makers. Opposition has also come from other professional educators, particularly those of a progressive persuasion, who fear that the new programs place undue emphasis on subject matter learning at the expense of the all around development of the child or adolescent, and hence represent, as they see it, a step backward rather than forward.

Some high school teachers welcome the new program and the materials being made available for teaching them but others are disturbed by the fact that the new curricula make it necessary for them to discard substantial portions of a lifetime of learning. It is understandable that an older teacher of mathematics, for example, who has spent years learning to teach arithmetic, algebra, or geometry effectively should be reluctant to accept new approaches to mathematics that require him to begin learning all over again.

Opposition to the new mathematics also comes from parents who protest that the new content makes it impossible for them to help their children with their homework. It is obviously true that a parent who studied arithmetic and algebra in the twenties or thirties finds himself helpless when faced by the new mathematics, but just how much parents *ought* to help children with their homework is an open question. Many parents who say they are helping their children could more accurately be said to be doing the children's work for them in order to insure that they will get better grades. In such cases it is the parent rather than the child who learns and it might be better if he kept hands off except to lend encouragement and answer occasional questions.

Although the new curricula have the endorsement of learned societies, academic scholars in some fields are not in full agreement regarding their content. In mathematics, for example, a number of university professors, including some distinguished mathematicians, have questioned the value of the new approaches and their appropriateness for elementary and secondary school students.

In spite of this opposition the new programs are catching on and it seems likely that they will greatly alter the content of most secondary school curricula within the years just ahead. They will do so only to the extent that they are found acceptable to teachers and school administrators, and to state and local groups of educators who are free to accept or reject. Because we have no national system of education, and are committed to the principle of state and local control of the schools, there is, up to now at least, no uniformality of standards and no national curriculum. No one has the authority to impose a new program. It must gain acceptance at the local or state level.

Before it is fully accepted, and becomes the standard or most prevalent pattern, any new curriculum should be carefully evaluated against the ultimate criterion—its long-range effect upon the children who study it. Such an evaluation takes time because it is not enough to know how the curriculum affects immediate test scores; we need to know how it influences the child's later success in college and in his career and also his adult outlook on life.

The collection of test scores and other statistics is not evaluation but only the first step toward evaluation. Evaluation is not complete until someone has made value judgments which are based upon the empirical data but which interpret the evidence and draw conclusions from it in relation to a clearly stated philosophy of the proper goals of education. Such an evaluation will be made more difficult by the fact that the older curricula now being replaced have rarely been adequately evaluated on a national basis in terms of such goals and, hence, comparison will be difficult. The present volume includes an excellent chapter on the subject by Lee Cronbach.

Many of the new programs reflect the view that the capacity of children to learn difficult material has been grievously underestimated in recent years. This is probably true, but it is important to keep in mind the fact that academic scholars, who work exclusively with selected college students, are prone to overestimate the capacity of unselected school children while elementary and secondary teachers, because they must work daily with students of all levels of ability and find their greatest frustrations with the slow learners, are prone to underestimate the ability of the brighter students.

Several of the authors quote with approval Jerome Bruner's dictum that "any subject can be taught effectively in some intellectually honest form to any child at any stage of development." Some of them seem to take this to mean that every subject *ought* to be taught at every stage of development—an interpretation that Bruner may not have intended and one that certainly deserves some critical examination. There is rarely time for everything at any one level and it may well be that the introduction to some subjects can be postponed without any ultimate loss while the introduction to others must begin early if the subject is to be taught most effectively.

Perhaps the most important fact about the new approach to curriculum making described in this book is that it promises better articulation between high school and colleges. The gulf between the two has been wide and, in recent decades, it has grown wider. Many of the present college programs seem to have been based upon the assumption that a student has almost no background in liberal education when he enters college and that the college must accept the full responsibility. It is obvious, however, that a boy or girl can and should gain a strong background in the major academic disciplines during his adolescent years. Now that school and college teachers are working together in curriculum construction it should be possible to design a program of liberal education that begins in the junior high school or earlier, continues through the senior high period and is brought to a high level during the first two years of college, provided that the college builds upon what has come before. Between the years of 12 and 20 there is ample time for liberal education if the years are used wisely and if the programs of the high school and college are properly articulated.

The programs described in this book will be revised and refined over the years in the light of experience with them. No one of the authors claims to have found the final answers. But these new approaches to curriculum making represent a tremendous step forward and will do much to improve the quality of American education in the years just ahead.

2

An Emerging Program of Secondary School Mathematics

MAX BEBERMAN · UNIVERSITY OF ILLINOIS

Introduction

In 1952, a few of us at the University of Illinois asked ourselves: Can able mathematicians together with skillful teachers develop materials of instruction and train high school teachers in their use so that the products of the program are enthusiastic students who understand mathematics? An affirmative answer could be justified only by a constructive existence proof, and we set ourselves the task of furnishing such a proof.

We are still at work on this task. The core of the working staff consists of Herbert E. Vaughan of the Department of Mathematics of the University of Illinois, and Gertrude Hendrix, William T. Hale, Eleanor McCoy, and myself of University High School, the laboratory school of the College of Education.[1] A group called the University of Illinois Committee on School Mathematics (UICSM) serves as an advisory board to the staff, and draws its membership from the Colleges of Education, Engineering, and Liberal Arts and Sciences. I serve as administrative head of the project; Hale and I teach some of the newly developed courses at the laboratory school; Vaughan

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[1] Others who, in earlier years, made substantial contributions to the development of instructional materials are G. P. Hochschild, B. E. Meserve, and D. A. Page.

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provides the principal mathematical substance of the program; Vaughan and I write the instructional materials, with considerable assistance from the other members of the staff; and Hendrix and McCoy direct the teacher-training phase of the project.

We now have courses for the four high school grades on trial in classrooms in a dozen pilot schools. Some forty teachers and over seventeen hundred students are participating. Some of these students are gifted eighth graders (or highly gifted seventh graders); the rest are students who would ordinarily be enrolled in conventional "college preparatory" or "academic" mathematics courses.

Our courses are still in the process of development. Portions of them have been used for as many as three consecutive years, but other portions are very recent revisions or are entirely new. One result of this experimentation and revision is our recognition of two major principles which we have used as guides in developing courses and in teaching students. For a time, these principles operated at a nonverbal level. It is only recently that we have been able to verbalize them and to identify them as our basic guides. A major portion of this report is devoted to the presentation and illustration of these principles.

The development of a new course of study is not undertaken in a vacuum. One has in mind an image of a student and a catalog of the student's knowledge and misknowledge. A student entering the ninth grade knows something about arithmetic and geometry; he has available to him a battery of algorisms for computing with "unsigned" real numbers, he is aware of some arithmetic generalizations, he has learned quite a few mensuration formulas, and he has solved many "practical" problems which involve applications of arithmetic and geometry. The curriculum developer also has in mind the traditional expectations of what a college-bound high school graduate should know of mathematics. He is expected, among other things, to solve equations (singly and in systems), to use algorisms and formulas in transforming algebraic and trigonometric expressions, to deduce theorems from postulates, to find ordered pairs which belong to relations, to graph relations, and to apply his knowledge to a host of geometric and physical problems.

We think that these objectives are sensible and proper, and our curriculum is planned accordingly. But we insist upon an important qualification: the student must *understand* his mathematics. Now, the word 'understand' and its close relative 'meaningful' have been bandied about in educational circles to a point where just about everyone pledges allegiance to the goal of teaching meaningful and understandable mathematics.[2] We have tried to translate these words into operational terms. We believe that a student will come to understand mathematics when his textbook and teacher use unambiguous language and when he is enabled to discover generalizations by himself. These two desiderata—discovery, and precision in language—are closely connected, for new discoveries are easier to make once previous discoveries are crystallized in precise descriptions (it is easier to discover how to solve equations when you know what an equation and a variable are!), and skill in the precise use of language enables a student to give clear expression to his discoveries. Despite the tie between these two facets of understanding, I shall, for convenience' sake, discuss them separately.

Precision of Language

The procedure through which a child becomes aware of a mathematical entity such as a number or a function is undoubtedly quite complicated and has yet to be described. However, let us assume that there are such things as mathematical entities, that their existence is nonphysical, and that human beings do develop awarenesses of them. As a child becomes aware of such an entity, he may want to talk about it. In such a case, he needs a name for it. Consider the preschool child who notices that to dress her three dolls she must have three dresses, three hats, three parasols, and three pairs of shoes. Her awareness of the *class* of sets of three things is an awareness of an entity. The entity is the number three and a name of the entity is the word 'three.' But the existence of the entity does not depend upon the invention of the word 'three,' and the fact that a child may be acquainted with the word 'three' cannot be considered a sure sign that he has even the slightest awareness of the number three. To say that a child understands the number three is to say that the child is aware of this class of matching sets. He demonstrates this awareness by asserting correctly (through action or through words) that a given set either belongs or does not belong to this class. If the child is to function as a social being, he needs to communicate his awareness and, therefore, he needs a name (a word, perhaps merely a gesture) to denote the mathematical entity.

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[2] Although mathematics educators now seem to regard 'meaningful mathematics' as platitudinous, it is greeted with warmth and surprise by most laymen. This lay attitude is surely an indictment of the conventional program.

The social intercourse which is facilitated by the invention of a name undoubtedly results in a sharpening of the awareness and, therefore, in a "deepening of the understanding" of the entity. But an increasing familiarity with a name should not invest it with the properties of that which it denotes. The name and entity are distinct and must not be confused. It is our contention that in the exposition of elementary and secondary mathematics there is so much confusion of names with their referents that in many cases the student has never discovered that there is a distinction between symbols and their referents. Confusion in exposition is of little consequence to a student who has managed to maintain for himself the distinction between mathematical entities and the symbols which denote them because most of the time, as the cliché goes, "the intention is clear from the context." But, for the student who has not yet become aware of the mathematical entities in question, an exposition which is guilty of this confusion is just about useless. It is even dangerous, for a student can through imitation give behavioral evidence of understanding even though the awareness which is part of understanding is missing. Let us consider some illustrations.

On several occasions I have given to seventh-grade classes the following problem:

> Find a number which when added to 7 gives 7 as the result.

(This problem followed several others of a similar type: Find a number which when multiplied by 3 gives 27 as the result, or: I am thinking of a number. If I divide it by 4, I get 6. What number was I thinking of?) In some cases, when a student said that 0 was the number in question, another student protested that 0 was not a number but that it was, instead, a place holder. Here, in rather bold terms, is an example of the danger arising from a confusion of the number 0 with the digit '0.' Even though every digit is a place holder in the decimal system of numeration, it is most unlikely that a student would protest, for example, that the number 6 is a place holder rather than a number. He has an awareness of the entity 6, and does not confuse it with any of its names even though one of its names is used as a digit. It is likely that the student learned that the symbol '0' was used as a mark in constructing numerals before he had become aware of the entity 0.[3]

Certain remarks made by junior high school students lead me to suspect that they believe that, among the rational numbers, there are pairs of rationals which can be added and that there are pairs of rationals which cannot be added. For example, they may say that "you can add $\frac{2}{7}$ and $\frac{3}{7}$ but you can't add $\frac{2}{3}$ and $\frac{1}{2}$." When a student asserts that the sum of $\frac{2}{7}$ and $\frac{3}{7}$ is $\frac{5}{7}$ and that the sum of $\frac{2}{3}$ and $\frac{1}{2}$ is $\frac{7}{6}$, he must mean that he has added rational numbers in each case. But he also recognizes that the simple algorism illustrated by:

$$\frac{2}{7}+\frac{3}{7}=\frac{2+3}{7}=\frac{5}{7}$$

cannot be applied to the expression:

$$\frac{2}{3}+\frac{1}{2}\cdot$$

In fact, he may even assert that he must first "change the numbers" before he can add. This colloquialism is harmless if he recognizes that '$\frac{2}{3}$' and '$\frac{4}{6}$' are names for the same number, and that '$\frac{1}{2}$' and '$\frac{3}{6}$' are names for the same number, and that when he writes '$\frac{4}{6}+\frac{3}{6}$' instead of '$\frac{2}{3}+\frac{1}{2}$' he is referring to the same sum by using a new expression which is more convenient because it can be simplified by the algorism illustrated above. But if he regards $\frac{4}{6}$ as a different entity from $\frac{2}{3}$ because '$\frac{4}{6}$' is different from '$\frac{2}{3}$,' he does not understand the rational number $\frac{2}{3}$; and perfect scores on tests which measure skill in adding rational numbers are not evidence of such understanding. (A similar example of the confusion of symbol with referent is the case of the senior high school student who stoutly maintains that you can add $2\sqrt{2}$ and $5\sqrt{2}$ and get an "exact" answer but that you can't expect to get an exact answer when you add $2\sqrt{2}$ and $5\sqrt{3}$.)

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[3] It has been suggested that many of the so-called "zero-difficulties" experienced by children in carrying out the multiplication and division algorisms can be attributed, at least in part, to the confusion between '0' and 0. In this connection see Robert S. Fouch, "The Un-sanity of Mathematics and Its Teaching," ETC. (Winter 1954), pp. 113–121.

Another illustration in support of our contention that comprehension can be blocked by a confusion of numerals with numbers is to be found in reactions to textbook treatments of "number systems with bases other than 10." Many students show considerable surprise and wonderment when they learn that they can do the same things with base-two "numbers" as they can with base-ten "numbers." The very use of the word 'number' in the description of this subject is misleading because what is under discussion is the construction of numeral systems, that is, *naming* systems. In textbooks one can read statements that there are binary numbers, trinary numbers, quinary numbers, octic numbers, decimal numbers, and duodecimal numbers, and that the *same numbers* in these different systems are *different*—for example, 31 in the quinary system is different from 31 in the decimal system. A revealing test of the understanding of someone who claims to understand "change of number base" is to ask (using conventional language) the following question:

> Take the prime number 13 in the decimal system. In the octic system this is the number 15. Is it also a prime number in the octic system?

Any hesitation at all in giving an answer to this question is a sign that the answerer's understanding is not all it should be. Of course, if the question is posed in language which shows a recognition of the distinction between number and numeral, the "problem" vanishes:

> Take the prime number whose decimal name is '13' and whose octic name is '15.' Is it a prime number?

As soon as one recognizes that primeness is a property of numbers, he also recognizes that it is not affected by changing the name of the number in question.

I have come upon an able student who thought that numbers in the binary system are bigger than in the decimal. This assertion is excusable if you are willing to believe that he meant numerals when he used 'numbers.' But, what about the student who maintained that there were *more* integers in the binary system than in the decimal system? It is hard to fathom the nature of this student's awareness of integers.

If the mathematics teacher's (and the textbook author's) sole job in the classroom were to furnish the student an example of someone in the act of "doing mathematics," there would be little need for worrying about the distinction between symbol and referent. And, it must be admitted, many students do learn mathematics by regarding teachers and authors in just such a light. The first actions of such students are imitative; the brightest ones among them eventually puzzle out meanings by themselves. However, we believe that teaching should be more than just something which enables students to learn to use symbols by imitation. Teachers and authors should deal directly with the problem of teaching students how to use symbols, and the procedure for doing so requires only that the expositor use an unambiguous mode of expression. If one is to write a description of how to use symbols, one must, when doing this, mention or refer to symbols. But in mentioning symbols one must use names for them. For example, in the sentence:

> '6363' contains '63' twice, but 6363 contains 63 one hundred one times,

the first clause refers to symbols, and the second clause refers to numbers. The symbols "6363" and "63" are names for the numerals '6363' and '63', respectively, while the numerals '6363' and '63' are names for the numbers 6363 and 63, respectively. Undoubtedly, a reasonably intelligent person could divine the author's intention if he wrote:

> 6363 contains 63 twice, but 6363 contains 63 one hundred one times,

but the simple act of inserting single quotation marks to form names of symbols makes the meaning clear and immediate. Other examples of sentences involving both the use and the mention of symbols are:

1. '31425' has 5 digits and denotes a number which is divisible by 5;
2. '$3 + 4$,' '$8 - 1$,' and '7' are names of $3 + 4$;
3. '$\frac{2}{3}$' and '$\frac{4}{6}$' are different symbols, but $\frac{2}{3}$ is $\frac{4}{6}$;
4. 'the principal square root of 2' is a description of $\sqrt{2}$.

In the instructional materials which have been developed by the UICSM staff, careful attention is paid to the problem of distinguishing between the use and the mention of symbols. We feel that this distinction helps us to say precisely what we mean in those cases where a direct statement is useful. (There are cases where important notions can be communicated readily by example and in which the only value of a direct statement is that it provides the writer with an interesting exercise in rhetoric. The algorism for multiplying a whole number by 10 is such a case: the product of a whole number by 10 is the number named by adjoining a '0' at the right-hand end of the decimal numeral of the given number.) A student who has only a tentative feeling for the referents of the symbols used or mentioned in a statement is in a poor position to guess "from the context" the writer's intention. It is in such cases that precision of statement is an almost necessary condition for understanding.

Another compelling reason for distinguishing, both in written exposition and in teaching, between symbol and referent is that it prepares the student for a consistent and simple explanation of the use of letters in mathematical expressions. Here is an area of mathematical instruction that is fraught with linguistic difficulties. A student who has been deluded into thinking that a numeral is a number can be floored when he reads that a letter is a number also. (And the notion that a letter is a "changing number" must be surprising indeed!) A student who reads in a conventional textbook that a letter is a symbol for a number must experience a certain amount of uneasiness when he tries to understand explanations of the use of letters in sentences such as:

$$x + 3 = 5,\ x + 4 = 10,\ \text{and: } x^2 + 1 = 17.$$

In the first sentence he learns that 'x' stands for 2, in the second that 'x' stands for 6, and in the third, as a capstone to this silliness, that 'x' stands for both 4 and -4. By the time he encounters a sentence such as '$3 + \sqrt{x} = \sqrt{5 - x}$),' where he is told that 'x' stands for no number at all, he may not be overtly disturbed because he has given up trying to find a consistent explanation of the use of this peculiar symbol.

He may also be told in a conventional course that he can add $3x$ and $5x$ but not $3x$ and $5y$, although multiplication does not seem to be so selective.

He has learned that he can tell that -2 is a negative number by observing the minus sign in '-2,' but he has also learned that he is wrong if he uses the same criterion in deciding that $-x$ is a negative number.

He knows that when he multiplies or divides both sides of an equation by the same "quantity" there is some danger of altering the set of roots if he is not careful about excepting 0. But, since he feels free about adding the same quantity to both sides of an equation, he may experience some consternation when he compares the set of roots of:

$$3x + 5 - \frac{1}{x-2} + 11 - \frac{1}{x-2}$$

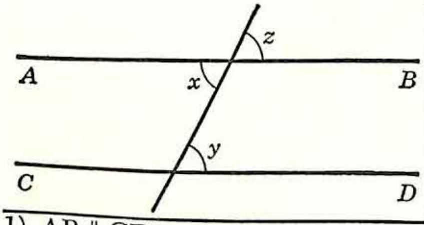
with the set of roots of:

$$3x + 5 = 11.$$

In his geometry course he may learn:

Axiom 5. A quantity may be substituted for its equal,

and then wonder what is wrong with the following demonstration:



Given: AB is parallel to CD.
To prove: $\angle y$ and $\angle z$ are vertical angles.

1) AB ∥ CD.	1) Given.
2) $\angle x = \angle y$.	2) Alt. int. ∡ are =.
3) $\angle x$ and $\angle z$ are vert. ∡.	3) Def. of vert. ∡.
4) $\angle y$ and $\angle z$ are vert. ∡.	4) Ax. 5. Q. E. D.

This catalog of oddities can be extended and elaborated.[4] However, I think that I have made the point that conventional exposition concerning letters in mathematical expressions is confused to such a degree as necessarily to confuse a student.

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[4] See Karl Menger, *The Basic Concepts of Mathematics* (Chicago: The Bookstore, Illinois Institute of Technology, 1957).

How does the UICSM handle the problem of explaining the use of letters? In the first place, our students are aware of the distinction between numerals and numbers. Although our ninth graders may not be able to *say* what numbers *are*, they are aware that numbers have existences apart from their numerals, and that a mark on paper such as a ‘5’ is not the number 5. They know, also, that each number has many numerals, that a sentence formed by connecting two numerals by an ‘=’ is an equation, that such an equation is a true sentence if the numerals connected by the ‘=’ are names of the same number, and is a false sentence if the two numerals are names for different numbers. A sample of the exercises which lead up to a consistent explanation of the use of letters is to convert:

$$\underline{\qquad\quad} + 5 = 9$$

into a true sentence by writing a numeral in the blank space, and to convert it into a false sentence by again writing a numeral in the blank space. We vary the appearance of these sentences-to-be-completed by using other marks besides blanks; for example:

$$\square + 3 = 8,\ 2 + \triangle = 1,\ 15 = 4 + \hexagon.$$

These expressions which contain ‘=’s and blanks or frames are also called ‘sentences’ or ‘equations,’ because they have the same form as sentences and equations. But the student quickly discerns the difference between, say:

$$\square + 3 = 8,$$

and:

$$7 + 3 = 8,\ \text{or: } 5 + 3 = 8.$$

In the second and third cases we have sentences which are either true or false, while in the first case we have a sentence which is neither true nor false. (Although ‘8’ is a numeral, ‘$\square + 3$’ is not. So, the ‘=’ in ‘$\square + 3 = 8$’ connects neither numerals for the same number nor numerals for different numbers.)

The student notes that a sentence such as:

He is the author of David Copperfield

is like the sentence:

$$\square + 5 = 13$$

in that each is neither true nor false and each can be converted into a sentence which is either true or false by replacing the 'He' or the '□' by a name. The marks 'He' and '□' are pronouns, marks which hold places for names. Students are easily led to invent the word *pronumeral* to designate the class of pronouns which hold places for numerals. The transition from frames as pronumerals to letters as pronumerals is readily accomplished—it is easier to write letters than to draw frames. But the important notion is well established: pronumerals are not numbers nor do they stand for numbers: they are marks which stand in place of numerals. By convention, if a pronumeral occurs more than once in a sentence, and one of its occurrences is replaced by a numeral, then all of its occurrences are replaced by that numeral. For example, two conversions of '$x - 5 = 7 - 2x$' are '$8 - 5 = 7 - 2\cdot 8$' and '$4 - 5 = 7 - 2\cdot 4$.' The job of *solving an equation* is simply one of finding true conversions of the equation. A number whose name converts an equation into a true sentence is a solution or root of the equation. The equation '$x^2 + 1 = 17$' has two roots 4 and -4 because these are the only numbers whose names convert the equation into a true sentence.

In developing the idea of the pronumeral as a place holder for a numeral it is easy to prepare students for the important job of stating generalizations about numbers. For example, when a student encounters the sentence '$x + 3 = 3 + x$,' he guesses quickly that each conversion of this sentence is true because the conversion is an instance of the commutative principle for addition. (He is aware of the commutative principle for addition, as well as other properties of addition and multiplication and in our program he has learned the word 'commutative' before he has encountered pronumerals.) In fact, he may even maintain that '$x + 3 = 3 + x$' is "always" true, or that '$x + 3 = 3 + x$' is true for all numbers. What he is saying, of course, is that when any number is added to 3, the same sum is obtained as when 3 is added to it. Although the slight ambiguity in the foregoing sentence is not troublesome, when the student tries to verbalize other generalizations, such as the distributive principle for multiplication over addition, he finds that the ordinary procedure for using pronouns in English does not lend itself readily to precise statements of even moderately complex generalizations. He needs a method of "keying" pronouns, and keying is accomplished by using a *quantifier* phrase such as the prepositional phrase in:

$$\text{For all numbers } x, y, \text{ and } z,\ x \times (y + z) = x \times y + x \times z.$$

The displayed sentence is the distributive principle for multiplication over addition. The student must not regard this sentence as a statement about the letters '*x*,' '*y*,' and '*z*.' Instead, he should regard it as a statement about multiplication and addition of numbers, and should see the statement as being equivalent, in some fashion, to the conjunction of its instances. An instance of this generalization is obtained by taking the sentence which follows the quantifier, selecting a number from the set of *all numbers*, writing a name for it in place of each occurrence of '*x*,' and repeating this procedure for '*y*' and '*z*.' Thus, an instance is:

$$9 \times (3 + 7) = 9 \times 3 + 9 \times 7.$$

An illustration of the ease with which a student can state a generalization which he has discovered is provided by an incident which occurred in a class in one of our pilot schools. A student had difficulty in finding the number which when multiplied by 7 would give 5 as the product. After some experimenting, she discovered that 5/7 was the number in question. The teacher then posed a series of questions:

> What multiplied by 7 gives 3?
> What multiplied by 7 gives 9?
> What multiplied by 12 gives 17?
> What multiplied by 0 gives 5?
> What multiplied by 93 gives 88?
> What multiplied by 1087 gives −95?

When rapid answers to questions such as the last were obtained, the teacher was certain that the student was aware of a generalization. He then asked for a statement of the principle the student was using. A good rendering of the generalization in ordinary English might be: the number you multiply by a second number other than 0 to get a third number is the quotient of the third number by the second number. There are very few ninth graders who can use

English in such a precise fashion. But there were many students in that class who were able to offer the following statement:

$$\text{For all numbers } x \text{ (except 0) and } y,\ x \times \frac{y}{x} = y.$$

Although the neologism 'pronumeral' is used in the early part of our beginning course instead of the more usual 'numerical variable,' the standard terminology is introduced just as soon as the need arises for the generic term 'variable.' This occurs in the latter part of the ninth grade when the student notices some of the properties of operations with sets. For example, he may observe that in the sentence:

$$x \cup y = y \cup x,$$

the letters hold places for names of sets instead of names of numbers. Although the letters are pronouns, they are not pronumerals. Here we introduce the word 'variable.' (The fact that a word with the connotation of change should be used for this purpose seems strange to our students.)

One can give a defense of the language used in conventional courses by saying that many of the usages are colloquial or elliptical, and that such idiomatic modes of expression are helpful in facilitating informal communication. We grant the importance of using colloquialisms and elisions, but we also insist that students know what is being idiomatized. For example, if a student says that "you can add $3x$ and $5x$," we want him to understand that he means that the distributive and commutative principles can be used to transform the expression '$3x + 5x$' to '$8x$,' and that he does not mean that $3x$ and $8x$ can be added because you can add "like numbers." If he says '$\angle ABC = 30°$,' we want him to intend this as an abbreviation for 'the degree-measure of $\angle ABC = 30$' or for '$\angle ABC$ belongs to the magnitude $30°$.' He may talk about the line '$3x + 5y - 7 = 0$' but he should understand that he means the line which is the set of all ordered pairs (x, y) such that $3x + 5y - 7 = 0$.

Although the careful use of language in textbook exposition is perhaps more a writer's problem than it is a mathematician's problem, our attempt to be precise has had important consequences for the mathematical content of our program. Here are some examples of these consequences.

Once he is convinced that numerals are not numbers, it is natural for the student to wonder what numbers are. While it is probably too difficult to give a complete answer to this question in secondary school courses, we have given examples of how some number systems are constructed, and we have compared these developments with a postulational approach. The complex-number system is a case in point. In conventional courses, students first learn that there is no number whose square is −1, and later are asked to accept the notion that there is such a number. It is certainly more satisfying to students to learn that complex numbers are ordered pairs of real numbers, to learn, next, the definitions of the operations with complex numbers, and to show that the complex-number system is a field, and finally, to derive the theorem that the complex number (0, 1) is a square root of the complex number (−1, 0).

The semantic notion that a noun ought to have a referent has led us to give precise descriptions of relations and functions. The customary vagueness that surrounds the word 'function' in conventional courses vanishes when a student realizes that a function is an entity, a set of ordered pairs in which no two elements have the same first component. The pedagogic advantage of this type of precision is apparent, for example, when the teacher deals with the concept of the inverse of a function. A student who understands that a function is a set of ordered pairs has no trouble in "picturing" the inverse of a function, or in determining whether a function has an inverse. Also, a student who has learned the set-of-ordered-pairs definition for functions does not have the common misconception of conventional students that a function is an equation. Thus, our students are completely at ease with the idea of functions whose domains and ranges do not consist of the same kind of elements. They respond well to the development of the circular functions, cosine and sine, from the notion of a "winding" function. The winding function is a function whose domain is the set of real numbers and whose range is the set of ordered pairs which belong to the unit circle. Although the functions cosine and sine are functions from numbers to numbers, we easily "extend" this idea for purposes of application to functions whose domains are sets of classes of congruent angles, and to functions whose domains are sets of radian-measures of angles or degree-measures of angles.

The fact that our students are aware that nouns should have referents helps them in understanding the role of primitive terms in a postulational system. Primitive terms are nounlike words without referents (and, for this reason, postulates are statements without content). We have found it relatively easy to work with models of a deductive theory because our students understand that one may construct a model by supplying referents for the primitive terms. Also, they have no trouble in understanding the logical role of definitions in a deductive theory because they are familiar with a mode of expression which refers to replacing one string of symbols by another.

Discovery

A second major principle which has guided us in developing the UICSM program is that the student will come to understand mathematics if he plays an active part in developing mathematical ideas and procedures. To us this means that after we have selected a body of subject matter to be learned we must design both exposition and exercises in such a way that the student will discover principles and rules.

It may be argued by some that this procedure is too authoritarian, and that the most desirable situation would be to permit the student to proceed without preselection of content and without direction. We concede that this may be a desirable state of affairs in a class which is under the tutelage of a gifted teacher. But we are developing a curriculum for the mass of schools which demand a preselected content and for the mass of teachers who want textbooks. And we maintain that even with preselected content there are opportunities for the expression of individuality on the part of the student. Some of our most fruitful text developments and revisions have come from problems suggested by our students and from leads which they have uncovered and pursued.

In what follows I present several examples of developments in our program which result in discoveries by students. I do this to the mathematical content of our program. Here are some examples of these consequences.

Once he is convinced that numerals are not numbers, it is natural for the student to wonder what numbers are. While it is probably too difficult to give a complete answer to this question in secondary school courses, we have given examples of how some number systems are constructed, and we have compared these developments with a postulational approach. The complex-number system is a case in point. In conventional courses, students first learn that there is no number whose square is −1, and later are asked to accept the notion that there is such a number. It is certainly more satisfying to students to learn that complex numbers are ordered pairs of real numbers, to learn, next, the definitions of the operations with complex numbers, and to show that the complex-number system is a field, and finally, to derive the theorem that the complex number (0, 1) is a square root of the complex number (−1, 0).

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It may be argued by some that this procedure is too authoritarian, and that the most desirable situation would be to permit the student to proceed without preselection of content and without direction. We concede that this may be a desirable state of affairs in a class which is under the tutelage of a gifted teacher. But we are developing a curriculum for the mass of schools which demand a preselected content and for the mass of teachers who want textbooks. And we maintain that even with preselected content there are opportunities for the expression of individuality on the part of the student. Some of our most fruitful text developments and revisions have come from problems suggested by our students and from leads which they have uncovered and pursued.

In what follows I present several examples of developments in our program which result in discoveries by students. I do this to illustrate our notion of discovery. The illustration is followed by a defense of the "discovery method" of teaching mathematics.

Teachers of the conventional course in beginning algebra recognize the fact that students are very quick in discovering a rule for adding directed numbers. In fact, the usual rule stated in textbooks is a necessarily complicated description of an algorism, and usually contains some confusion of symbol with referent. Any student capable of learning algebra in the first place will have invented this algorism. Any student who is able to interpret the textbook description is also able to carry out the algorism for adding without using the text description. Hence, our earliest opportunity for an important discovery in the UICSM program occurs in connection with the rule for adding directed numbers. All students succeed in this first attempt. On the other hand, the complete algorism for multiplication is seldom discovered under conventional treatments. Moreover, since we regard the positive numbers as different from the nondirected numbers, our students cannot discover that "$(+4) \times (+3) = +12$ because $(+4) \times (+3) = 4 \times 3$." In fact, since we regard a positive number such as $+4$ as different from the number 4, we were compelled to invent a physical interpretation for symbols such as '$(+4) \times (+3)$' and '$(+4) \times (-3)$' just as we invented a physical interpretation for symbols such as '$(+7) + (-8)$' and '$(-3) + (-2)$.' (Of course, the algorism must eventually be justified by a definition of the operation in question and a definition of directed numbers, or from postulates for the directed-number system. But, since we feel that neither the constructive nor the postulational approach is appropriate at the eighth- or ninth-grade levels, we make do with a carefully contrived and reasonable physical interpretation.) Once a student accepts the physical interpretation, he can use it to simplify symbols such as '$(-4) \times (+3)$.' He is eager to find a way to get answers without using the physical interpretation. So he hunts for an algorism; when he finds it, he says that he has a short cut. The student who is slow to discover the algorism can continue to use the physical interpretation; the fact that others in the class are getting answers with great speed is usually enough to spur him on toward discovery.

It is important to point out here that it is unnecessary to require a student to verbalize his discovery to determine whether he is aware of a rule. The teacher can use a sequence of questions to determine whether the awareness is present. In fact, immediate verbalization has the obvious disadvantages of giving the game away to other students as well the more serious disadvantage of compelling the student to make a statement when he may not have the linguistic capacity to do so. This is especially the case when a student does not yet know how to use variables. A premature verbalization is, almost by definition in such a case, imprecise and, thus not a faithful rendering of what the student actually believes, or is coming to believe. The teacher's acceptance of an imprecise verbalization is a signal to the student that he has completed the process of searching for a generalization. And even a precise verbalization from the student is not a sure sign that he is aware of the class of instances of the generalization, for he may regard the generalization itself as just another "instance." (The preceding sentence is a possible explanation of the phenomeon of the student who has "learned" a rule or has even "discovered" one as evidenced by his stating it, but who misapplies it in subsequent exercises.) This technique[5] of *delaying* the verbalization of important discoveries is characteristic of the UICSM program, and differentiates our discovery method from other methods which are also called 'discovery methods' but which always involve the immediate verbalization of discoveries.

One should not infer from this discussion of delayed verbalization that we believe that verbalization is unimportant in the learning of mathematics. Verbalization is necessary, for example, in the many cases in which a student believes that he has discovered a generalization, and wants to show that it is a theorem.

A second area in which the UICSM curriculum insists upon discovery is that of solving simple equations and inequations. When a student understands what an equation is and what is meant by solving an equation, he is ready to devise his own algorisms for solving equations and inequations such as:

$$x \times 3 = 9, \qquad 3x = 15,$$

$$2(x+1) - 5(3-x) = 29, \qquad \frac{5x+1}{3} = 7,$$

$$|x-3| = 4, \qquad |2x+1| < 7.$$

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[5] Gertrude Hendrix, "A New Clue to Transfer of Training," *Elementary School Journal*, XLVIII (December 1947), 197–208.

Many of the teachers working with our program in pilot schools expressed considerable skepticism, at first, about the ability of students to do this without being given the formal algorisms ("doing the same thing to both sides") beforehand. The success of their students was a source of gratifying surprise to them. Students develop considerable facility in solving equations of the type illustrated and are well motivated to learn the formal algorisms when they encounter an equation such as '$3x - 2 = 7 - 5x$' which does not yield to what they call "the common-sense method" but which is much simpler in appearance than many they have already solved.

A third area for invention is that involving rules for manipulating algebraic expressions. Conventional textbooks place great stress on giving step-by-step descriptions of the algorisms for manipulation and simplification. Our contention is that these rules should be invented by students since they are merely short cuts in applying basic principles. Once a student has learned what is meant by 'equivalent expressions' and the basic principles of arithmetic (essentially, the properties of a field), he is ready to simplify expressions in a meaningful way. Consider, as an example, the expression '$3x + 5x$.' After just a very few replacements of the 'x's by numerals, the student is ready to conjecture that '$8x$' is equivalent to the given expression. (That it is simpler is, for his purposes, just an aesthetic decision.) Since by 'equivalent' he means that a name of each number of the domain of the variable 'x' converts the sentence '$3x + 5x = 8x$' into a true one, he cannot verify equivalence of expressions by trying each member of an infinite domain. So he demonstrates the equivalence of the two expressions by deriving the simpler one from the given one as follows:

> By the commutative principle for multiplication, for every x, $3x + 5x = x3 + x5$. And, by the distributive principle, for every x, $x3 + x5 = x(3 + 5)$. Again, by the commutative principle, for every x, $x(3 + 5) = (3 + 5)x$, or $8x$. So, for every x, $3x + 5x = 8x$.

Now, I doubt whether there is a ninth grader to whom you would want to teach algebra who would believe that it was necessary to go through the preceding demonstration to discover the simpler expression '8.' Our students are urged to invent whatever procedures they can to arrive at simpler expressions as efficiently as possible. The formal derivation from basic principles is used only occasionally, mostly to demonstrate that short cuts are evidences of artistry rather than wizardry. Frequently, students will derive theorems from the basic principles, such theorems being nothing more than precise verbalizations of the short cuts. For example, ninth graders will insist, after two or three demonstrations of the type shown above, that "we prove once and for all that it always works that way." So they formulate and derive the sentence 'For every x, y, and z, $yx + zx = (y + z)x$,' invent a name for this generalization such as 'the second distributive principle' or 'the commutative-distributive principle,' and refer to this derived principle whenever they use it in demonstrating the equivalence of expressions.

The close ties maintained between the manipulation of expressions and the basic principles do not enable us to eliminate drill in manipulation. The student needs to practice using his short cuts in order to attain proficiency in their use. But during this practice the student knows that the algorisms he is using have a foundation in the basic principles and are not fortuitous procedures which seem to produce the right answers because the "book said so." Moreover, if a student errs in applying a short cut, for example, in simplifying '$3a + 2b$' to '$5ab$,' he is made aware of his error either by a classmate giving a counterexample to the generalization 'For every a and b, $3a + 2b = 5ab$,' or by the teacher insisting upon a derivation of the generalization from basic principles. (A question such as: How did you get '$5ab$'? is never raised, for the answer is obvious: the student found the sum of 3 and 2, put down a '5,' and wrote an 'ab' next to it.) Whenever possible the routine drill exercises are tied in with activities of greater intrinsic interest which may lead the student into discoveries. Examples: (1) drill in factoring is provided in exercises on solving quadratic equations; (2) practice in computing with directed numbers is provided in exercises on graphing sentences in a one-dimensional space ('$xxx < 0$,' '$|3x - 5| \leqslant 7$,' '$-(x - 3)/2$ is a nonnegative whole number'); (3) practice in adding and graphing complex numbers is incorporated in exercises in which the student plots several real multiples of a given complex number, adds a second given complex number to each of the real multiples, and discovers generalizations concerning collinearity; (4) intensive drill in plotting ordered pairs is obtained in carrying out dice-throwing experiments which lead to discoveries of generalizations in elementary probability theory.

A rather striking example of how routine drill can provide students with opportunities for discovering principles which were not included in the text occurred in one of our classes. The students had derived the two-point form for obtaining a linear equation where the locus contained two given points, namely: For each two points (x_0, y_0) and (x_1, y_1), $\{(x, y): (y_1 - y_0)(x - x_0) - (x_1 - x_0)(y - y_0) = 0\}$ is the line which contains (x_0, y_0) and (x_1, y_1). As drill, students were given triples of points and asked to determine whether the points were collinear. The "recommended" procedure was to use the two-point form to write an equation of the line determined by two of the points, and then check to see if the third point satisfied the equation. The setting up of the equation and the checking involved a fair amount of tedium, and the teacher soon discovered that the students were testing collinearity by determining whether a pair of first component differences was proportional to the corresponding pair of second component differences. This seemed to be more efficient than using the two-point-form technique, and just about every student in the class had hit upon the proportionality approach. The teacher then raised the question about the connection between the two approaches: Was this just a lucky coincidence, or was the two-point form essentially equivalent to the proportionality between pairs of corresponding differences of components of the points? A less sophisticated class would have been asked merely to think about this question, and not have been expected to give a formal derivation of one technique from the other. But this class was able to give precise descriptions of each technique, and so a formal derivation was in order. The question was answered by the students in considerable detail, and the ensuing discussion resulted in a fairly complete treatment of the notion of slope, including a derivation of the point-slope form for equations of nonvertical lines. The apparently universal tendency of children to reduce complex procedures to less complex and routine ones is a drive which will result in creativeness if the student is encouraged to find the "easy ways."

Somewhat related to the notion of discovery in teaching is our insistence that the student become aware of a concept before a name has been assigned to the concept. (This awareness frequently leads to the student's invention of a name, an activity which also involves creativity.) This point of view has enabled us to include in our program certain concepts which observers claim belong to the province of graduate courses in mathematics because of the "abstract" nature of the concepts. Our experience in teaching students that a relation is a set of ordered pairs is an example. To be sure, we take considerably more time in getting our students to arrive at this notion than can be taken at the graduate course level. (But it may also be the case that the reputation that this notion has of being difficult can be attributed to the fact that not enough time is devoted in graduate courses to building the concept for the student!) Through a series of activities and exercises in which a student becomes quite familiar with graphs and sets of ordered pairs (advancing from finite domains and ranges to infinite ones), the student builds for himself the concept that a set of ordered pairs is an entity and that membership in the set can be expressed by means of a graph, and, in some cases, by means of a simple sentence. Since the sentence also expresses in a vague way a "relation" between the components of a member of the set of ordered pairs, it is natural and convenient to regard the set itself as the relation. By focusing the student's attention on the graphs of relations, it is possible to build considerable geometric intuition about such properties of relations as reflexiveness, irreflexiveness, symmetry, asymmetry, antisymmetry, and transitivity. Our students are comfortable with phrases such as 'equality is a subset of congruence,' '$\geq$ is the converse of $\leq$,' and 'proportionality is an equivalence relation.' It is an easy step from the general study of relations to the study of functions as a special class of relations.

A criticism of the discovery method runs something like this. It consumes too much time. Since the most important thing you can do for high school students is to help them acquire consummate skill in manipulation so that they can solve lots of problems, it is best to give, by rule and by example and with dispatch, all of the manipulative algorisms. Do this so that the student will have the maximum amount of time available for practice. Occasionally, the teacher should ask a few questions as he derives a formula at the blackboard, but this type of questioning should not be pushed far because the student cannot be expected to know a derivation he has not seen carried out prior to that time. (Since only the brightest can ever reproduce derivations anyway, you can't include them on tests. Also, college entrance examination questions are multiple-choice, so there really is no good reason to waste effort on derivations.)

If the sole or even the major purpose of mathematics instruction in the secondary school were the preparation of students for college entrance examinations and for carrying out the manipulations required in analytic geometry and calculus courses in college, this criticism of the discovery method would be justified. Students with a strong interest in mathematics, particularly in problem solving, have thrived under a "tell 'em and test 'em" kind of regimen. But we know that many high school students, including the more able ones, have been repelled by mathematics courses, and, judging from the criticisms of college teachers, the products of the conventional manipulation-oriented curriculum are not well prepared for college mathematics.

When the manipulative procedures in mathematics are presented as perfected techniques to be learned and practiced by students, it is to be expected that students will inquire into the purpose of such activity. Clearly, there is small need in the life of the high school freshman for a highly developed talent in solving quadratic equations. He may believe you when you tell him that such a talent will "pay off" when he gets to college, but I do not think that he regards this as a valid reason for expending so much effort at the age of fourteen. He may even contrast his mathematics course with the one he is taking in literature. In literature he spends much time in learning things which make sense in terms of his present existence; in addition to the aesthetic appeal of literature, there is the appeal based on opportunities to understand himself and his human environment. I am afraid that the "how-to-do-it" course in mathematics does not fare well in a comparison with courses in literature or science. If we want to develop proficiency in the processes of mathematics (and this is a very important objective), and if we want students to feel that this activity is worthy of earnest pursuit, we need to work toward this end in an indirect manner. We need to involve students in problems whose solutions require the use of manipulative processes. But the problems must make sense to the students, and the students must be allowed to invent the methods of solution. These two aspects—sensible problems and opportunities to invent solutions—are the keys to maintaining interest in mathematics.

Now, a sensible problem for a ninth grader is not necessarily a sensible problem for an adult. The child's world is, of course, different from the adult's. It is rich in fantasy and not at all bounded by the exigencies of making a living and providing for old-age security. A child delights in the what-would-happen-if type of question, and, if he can give consistent answers to such questions, he regards this work as being eminently practical. If he is consistently unsuccessful in finding answers to these questions, they become artificial, uninteresting, and impractical.

Consider a student whose interest has been captured by the game of converting sentences containing variables into true sentences. (There must be sentences like '$|2x - 5| \leq 7$' and '$8 + |5(x - 3) + 4/x| = 3$' as well as like '$x + 4 = 9$' and '$3x = 12$,' or else the game loses its challenge.) You can sustain this interest by making him rely completely upon his own resources in playing the game, and you can destroy the interest by telling him all the rules for getting answers. You can make him receptive to developing techniques more formal than the ones he has invented by giving him sentences such as '$5x + 3 = 8 - 2x$' and '$x^2 + 5x = 6$.' The very fact that a student can discover techniques for himself is all the evidence he needs to see mathematics as a human endeavor which demands creative energy.

The discovery method of teaching is practiced by those who believe that mathematics is more than a tool to be used in solving the "real-life" problems of mankind. And the student who is seldom encouraged to discover even the real-life-tool features of mathematics will find himself ill equipped to construct solutions to new problems. Thus, the discovery method develops interest in mathematics, and power in mathematical thinking. Because of the student's independence of rote rules and routines, it also develops versatility in applying mathematics.

The Emerging UICSM Program

From the time of the initial use of its first textbook in September 1952 at the University of Illinois High School, the UICSM program has been subject to continual revision. We accept the need for revision as a normal concomitant of our work. That there is such a need is not to be wondered at, since we have not hesitated to make radical changes in the content and the development of the traditional program. We are continually apprised of the success of our efforts as a result of our close communication with the classes in our pilot schools. The weekly written reports from participating teachers, the regional training conferences, the results of our testing program, and the detailed reports made by our teacher coordinators, who visit the pilot schools, all serve as sources of information on which to base revisions. Although the final formulation of our syllabi is still to be made, we are now aware of a certain amount of stability in sequence and content. Thus, a description of the present content is in order.

Our program begins by leading the student to an awareness of the distinction between things and their names—in particular, of the distinction between numbers and numerals, and of the need when writing about numerals (or other expressions) to have names for them. He is then told of the existence of real numbers ("directed numbers") as contrasted with the "unsigned" numbers of arithmetic with which he is already familiar. Through the use of real numbers in solving problems he discovers how to add and multiply them, and he discovers that the operations of addition and multiplication have the usual properties of commutativity, associativity, etc. He learns of subtraction and division as inverse operations, and studies order relations and the absolute-value operation. He discovers the usefulness of numerical variables both in connection with the problem of expressing the properties he has discovered of these operations and relations and in the use of equations and inequations in solving "worded" problems. In the former connection, he also learns something of the procedure of deducing a sentence from other sentences; and while solving equations and inequations he becomes aware of the set concept and develops some of the notation (and concepts) of the algebra of sets. Finally, he studies Euclidean plane geometry from an informal point of view. In this development, stress is placed on the notions of measures of intervals, arcs, angles, and plane regions, and the main elementary properties of angles, triangles, quadrilaterals, and circles are discovered either by measurement of figures or by deduction of theorems from previously discovered theorems.

The second year deals, first, with the notion of ordered pairs and a study of the solution sets of equations and inequations in two variables. After further development of the algebra of sets, the student arrives at the concept of a relation as a set of ordered pairs, and notices such properties of relations as reflexiveness, transitivity, antisymmetry, and so forth. He discovers the connection between equivalence relations and partitions. He develops the two-point form for linear equations of lines, and the two-point form for parametric equations of lines (incidentally discovering and using the relation of proportionality for ordered pairs of real numbers), and finds methods for studying the intersection properties of number plane lines. Next, he considers those relations which are functions. He discovers that some functions have inverses. As illustrative numerical material, he studies linear and quadratic functions. He now reviews the number system of arithmetic (the "unsigned" real numbers) by accepting certain principles as postulates and deriving others from these. This review forms a basis for a development of the real-number system in which the real numbers are defined to be equivalence classes of ordered pairs of numbers of arithmetic, and the properties of the real numbers as an ordered field are derived from the definitions of the operations of addition, opposition, multiplication, and reciprocation together with the postulated facts concerning the system of numbers of arithmetic. In this development he arrives at the usual algorisms for multiplication and division of polynomials. A discussion of ways in which the numbers of arithmetic can be constructed from simpler number systems leads to the consideration of the natural numbers and the introduction of the principle of mathematical induction. Recursive definitions and proof by mathematical induction are treated at length, and illustrated by the use of Σ-notation and the theory of arithmetic progressions.

Our third year begins with a study of exponents, in which use is made of recursive definition and proof by mathematical induction, and a study of logarithms as exponents. Here the student begins to develop the concept of continuity and the limit concept; the theory of geometric progressions, and the binomial series come in naturally at this point. Next, the complex-number system is constructed on the basis of the system of real numbers. The procedure is such that the student first learns about the complex numbers as forming a linear vector space and on this basis (linear independence and so forth) makes the familiar applications of complex numbers to geometry. This is followed by a rather detailed process of discovering a suitable definition for multiplication of complex numbers. Finally, the student considers polynomial functions and studies such aspects of the theory of equations as the factor theorem, synthetic division, and curve tracing.

The fourth year contains a treatment of the circular functions based on a winding function. The emphasis is on such properties as periodicity, evenness and oddness, and monotonicity, and on "analytic trigonometry" rather than on "triangle solving," although applications are made to two- and three-dimensional mensuration problems. Solution of equations which involve the circular functions is based on a careful treatment of the inverse circular functions. The work on circular functions is followed by an outline of a purely deductive treatment of Euclidean plane geometry in which the student learns that a deductive theory can be obtained by abstraction of postulates from a model and deduction of theorems from these postulates without reference to the model, and that such a deductive theory can then be reinterpreted to yield information about other models. The remainder of the course is devoted to a study of plane and solid geometry by analytic methods.

Conclusion

The UICSM program is a product of the combined efforts of mathematicians and teachers. It is an attempt to determine what the teacher must do to bring to the mind of the adolescent some of the ideas and modes of thinking which are basic in the work of the contemporary mathematician. The success of this attempt is a result of the dedication of our staff and of the participating teachers in the pilot schools, and of the generous support of the University of Illinois and of our foundation sponsor, the Carnegie Corporation of New York.

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The History and Status of the School Mathematics Study Group

WILLIAM WOOTON[1] · LOS ANGELES PIERCE COLLEGE

The School Mathematics Study Group (SMSG) represents a national effort on the part of professional mathematicians and mathematics educators to improve the mathematics training of our nation's youth at all levels from kindergarten through the twelfth grade. It seeks to effect the improvement by influencing a variety of factors: textbooks, course content, teaching, teaching aids, enrichment materials, and pupil attidudes toward mathematics. Financial support for the Group derives solely from the National Science Foundation, which has, since 1958, supplied in excess of five millions of dollars for the purpose. From its inception, the Group has sought to work cooperatively with all other groups interested in improving the mathematics curriculum in the schools of the United States, as well as with similar groups in other academic areas.

SMSG was formed early in 1958 in response to what had become an obvious need. The shortcomings of the mathematics curriculum of our schools during the 1950's have been detailed many times. In particular, the static nature of the offerings seemed especially distressing to many thoughtful mathematics educators, who could see the mathematical needs of our society changing at an ever increasing rate. Not only was more mathematical knowledge being required on the part of more people than ever before, but the world of tomorrow seemed destined to make still greater demands. In the opinion of these educators, the existing curriculum could not meet the demands of the present, much less the demands they could see looming in the future.

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[1] The writer gratefully acknowledges the valuable assistance afforded him by Professor E. G. Begle, Director, School Mathematics Study Group, in the preparation of this chapter.

Among those becoming concerned about the mathematical training of American youth were the mathematicians themselves. For many years, since the era of World War I in fact, the mathematicians as a body had evidenced little concern for mathematics at levels other than the frontiers of research. However, the palpable shortage of skilled mathematicians during and following World War II caused a significant number of them to question the wisdom of this policy. It seemed evident to many of them that one reason for this shortage was the failure of the traditional school mathematics offerings to interest young people in the subject, or, indeed, to acquaint them with more than its rote computational aspects. They were also convinced that much of the trouble with the traditional curriculum could be attributed to the lack of communication between the professional mathematicians and the corps of mathematics teachers in the schools of the country. Precisely because the mathematicians had refrained from making their influence felt in the area of subject matter content in mathematics courses, this task had fallen by default to persons whose mathematical knowledge rendered them less well qualified to assume such responsibility. The amount of mathematics in existence today is so large and of such diversity that no single person is capable of mastering more than a small part of it. Without the assistance of those whose professional depth of training gives them perspective about the whole field and its applications to today's society, no real improvement seemed possible. It was this consideration perhaps more than any other that led to the establishment of the School Mathematics Study Group.

In late February of 1958, a conference of mathematicians convened at the Massachusetts Institute of Technology to explore ways and means of reopening lines of communication between the professional mathematicians and those concerned with the teaching of mathematics in the schools. At this conference, the mathematicians were briefed on the activities of the Physical Sciences Study Committee (see Chapter 4) which, under the leadership of Professor Jerrold Zacharias of MIT, had been making significant contributions to the improvement of the physics curriculum in the nation's high schools. As a result of a resolution passed at this conference, the President of the American Mathematical Society (AMS), after consulting with the Presidents of the Mathematics Association of America (MAA) and the National Council of Teachers of Mathematics (NCTM), appointed a small committee of educators and university mathematicians to organize a School Mathematics Study Group, whose objective would be the improvement of the teaching of mathematics in the schools. When called upon, Professor Edward G. Begle, then of the mathematics department of Yale University, agreed to serve as Director of the Group. In addition, the organizing committee appointed an advisory committee consisting of college and university mathematicians, high school teachers of mathematics, experts in education, and representatives of science and technology to work with the Director.

The membership of the Advisory Committee reflected what was to become the hallmark of SMSG. From the beginning, the Group has insisted that only the closest kind of cooperation between mathematicians and experienced teachers and supervisors can produce the kinds of improvements in mathematics education the times demand. The role of the mathematician is that of supplying the mathematics most appropriate to the present and future needs of the students. In addition, he must make sure that the mathematics is presented correctly, that is, that the concepts involved are not misrepresented or misinterpreted in teaching situations. The mathematics teachers and supervisors, in turn, must interpret the work of the mathematicians in language meaningful to the student. They must see that the classroom presentation keeps the concepts within the students' intellectual reach, and that the subject matter is presented in an interesting and challenging way. Each of these specialties has an indispensable contribution to make to the presentation of mathematics at all levels in our schools, and every project undertaken by SMSG has involved representatives of both groups.

Basic policy for SMSG is set by the Advisory Committee (or, as it has since been retitled, Advisory Board) whose membership has always been kept broad to avoid the possibility of individual axe grinding. All projects undertaken by SMSG are supervised by a panel consisting of both mathematicians and representatives of the schools. After SMSG had been working for a few years, it became clear that the Group would need to continue operations indefinitely. A set of bylaws was recently adopted which make this possible, and which are designed to keep SMSG an active avenue of communication between the mathematicians of the country and those responsible for the mathematical education of our youth.

The earliest formal statement of the objectives of SMSG was couched in these terms:

> . . . Our society leans more and more heavily on science and technology. The number of our citizens skilled in mathematics must be greatly increased; an understanding of the role of mathematics in our society is now a prerequisite for intelligent citizenship. Since no one can predict with certainty his future profession, much less foretell which mathematical skills will be required in the future by a given profession, it is important that mathematics be so taught that the student will be able in later life to learn the new mathematical skills which the future will surely demand of many of them.
>
> To achieve this objective in the teaching of school mathematics, three things are required. First, we need an improved curriculum which will offer students not only the basic mathematical skills but also a deeper understanding of the basic content and structure of mathematics. Second, mathematics programs must attract and train more of those students who are capable of studying mathematics with profit. Finally, all help possible must be provided for teachers who are preparing themselves to teach these challenging and interesting courses.
>
> Each project undertaken by the School Mathematics Study Group is concerned with one or more of these three needs.

SMSG realized that the job facing any group attempting to change the curriculum of the schools of the United States is a difficult one. The American people are dedicated to the principle of local control of education, and there is, therefore, no direct means of influencing what goes on in the classrooms of the country. The only way to effect changes in this area is to convince local school authorities that such changes are in the best interests of both the students in their charge and our society as a whole. Moreover, these authorities must be persuaded in numbers large enough to have an impact on the national educational picture as a whole.

Local groups were already at work on the problem. As early as 1952, the University of Illinois Committee on School Mathematics (see Chapter 2) under the vigorous leadership of Professor Max Beberman was spreading before the eyes of the mathematical community a bold new design for a secondary school mathematics curriculum. By 1958, other groups at the University of Maryland, the University of Minnesota, Ball State Teachers College, Southern Illinois University, and Boston University were suggesting new method and content for junior and senior high school mathematics classes. The Commission on Mathematics of the College Entrance Examination Board (CEEB) and the Curriculum Committee of the NCTM were formulating reports that would present detailed suggestions for improved mathematics curricula for secondary schools.

SMSG was prepared to augment these efforts by bringing to bear on the problem the combined thinking and persuasive influence of a broad spectrum of the professional mathematicians and experienced school teachers and supervisors of the country.

The question of how best to exert an influence on the curriculum had an obvious answer. Rightly or wrongly, the most important factor in determining the subject matter content of our junior and senior high school mathematics classes is the textbook. Individual teachers can, should, and do use textbooks in widely varying ways and to greater or lesser degrees. However, on the level of practicality, the textbook determines almost exclusively *what* is taught and, to a large extent, *when* things are taught. If SMSG were to influence the mathematics curriculum in the United States quickly and effectively, this influence would almost certainly have to be exerted through the medium of textbooks. Therefore, it was decided that among the first items of business for the Group would be that of writing sample textbooks displaying a complete sequence from grades seven through twelve of the kind of mathematics the Group, in its collective judgment, deemed appropriate for today's college-capable student.

During the summer of 1958, SMSG held a four-week meeting at Yale University for the purpose of planning the textbooks. This meeting was attended by some forty-four mathematicians and high school teachers and supervisors. The mathematicians present included representatives from a number of different branches of mathematics, from a variety of academic institutions, and from industry. The high school specialists included teachers and supervisors of clear that the Group would need to continue operations indefinitely. A set of bylaws was recently adopted which make this possible, and which are designed to keep SMSG an active avenue of communication between the mathematicians of the country and those responsible for the mathematical education of our youth.

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There were three important outcomes of this planning session. First, a decision was made to use as a point of departure the outline for a curriculum proposed by the Commission on Mathematics of the CEEB. Second, subgroups of the participants prepared preliminary outlines for textbooks at each grade level. Third, and perhaps most important, the session demonstrated beyond question that mathematicians and high school teachers could collaborate effectively on matters having to do with the school mathematics curriculum.

The next task was to write the sample textbooks. Two general means of doing this presented themselves. One way in which SMSG could have gone about it would have been to acquire the services of a small group of experienced writers and asked them to undertake the job. For what SMSG was trying to accomplish, however, this approach had prohibitive drawbacks. For one thing, the time involved in producing books in this way is very great. Indeed, for a sequence of books encompassing five grade levels it could stretch out to more than ten years. But more serious than the time involved was the problem of trying to embody the consensus of a wide variety of viewpoints in the books. Any such consensus is difficult enough to secure when proponents of diverse ideas can indulge in a face-to-face continuous dialogue; when it is sought by means of written criticism on material already in manuscript form it is virtually impossible to obtain. Lacking such consensus, what could be offered to the schools would simply amount to the personal opinions of a small group of writers.

The other alternative was the writing session where, rather than a small number of persons writing a large number of books, there would be a large number of persons writing a relatively small number of books. Granting that a textbook written by a committee is unlikely to be as effective as one written by a skilled individual writer or pair of writers, there were still overwhelming advantages to be obtained by using a committee approach to the task. To begin with, all SMSG proposed to do was produce sample textbooks, not definitive ones; the curriculum displayed by the books was to be the important thing. Secondly, books can be written very rapidly this way, and time was considered a vital factor. Thirdly, books written in this fashion can reflect the combined thinking of many people, and this, too, was something that the Group felt imperative if the results were to be acceptable to large numbers of teachers. Lastly, and perhaps most importantly, writing sessions could bring together the skills of both subject matter specialists and teaching specialists. Every effort could be made to see that not only was the content of the books the most appropriate mathematics, but that it was presented in a teachable manner.

Preliminary versions of the SMSG sample textbooks were written during the summer of 1959 at two-month writing sessions held at the Universities of Michigan and Colorado. The Michigan session concentrated on grades seven and eight, while that held at Boulder, Colorado devoted its attention to grades nine through twelve. All of the writers and their families were housed in dormitories on the campus where they worked. By sharing the same living quarters, recreational facilities, and working space, the participants were able to establish a group purpose that contributed heavily to the success of their efforts. Because a considerable amount of discussion and exchange of opinion occurred at mealtimes, in the evening, and over the weekends, the whole writing session became, in a sense, a continuous working period. Each textbook was written by a subgroup composed of both college and high school specialists, who wrote, criticized, and revised numerous drafts before arriving at a final version.

The books produced at these writing sessions were classroom-tested in more than seventy different schools during the academic year 1959–60. The books were then completely revised during another writing session conducted at Stanford University in the summer of 1960. The revisions were made in the light of the experiences of the teachers who had conducted the classroom tests. Each teacher in the testing program submitted to SMSG a detailed report of the problems arising during the teaching of each chapter in each textbook, together with their suggestions for improvements. The data obtained from these reports made it possible to improve the presentation materially, and following the Stanford session the revised sample textbooks were made available to any who wished to purchase them.

The mathematics embodied in these textbooks, while largely that of the traditional curriculum, presents the subject in a new and more meaningful way. Important mathematical skills and facts are stressed, but equal attention is paid to the basic concepts and mathematical structures that give meaning to these skills and provide a logical framework for these facts. The material included in the sample textbooks for grades seven and eight is designed not merely to round out the work of the elementary grades, but also to form a sound intuitive basis for the algebra and geometry courses to come. Briefly, the content of the SMSG sample textbooks is as follows:

Grade 7: Numeration; number systems; plane geometry (intuitive); and applications of these
Grade 8: Graphs; plane, solid, and nonmetric geometry (intuitive); probability; additional work with number systems; and applications
Grade 9: Elementary algebra
Grade 10: Euclidean plane and solid geometry
Grade 11: Algebra and trigonometry
Grade 12: Elementary functions and matrix algebra

Accompanying each textbook is a commentary for the teacher, which includes not only the usual materials (discussion of teaching problems, solutions for the exercises, and so on) but also discussions and deeper expositions of the mathematics covered in the textbook. These commentaries have proved of great help to many teachers whose mathematical backgrounds render the transition from the use of traditional to SMSG material somewhat difficult.

As remarked earlier, SMSG's purpose in writing sample textbooks was to attempt to influence the junior and senior high school mathematics curriculum by providing a concrete example of the kinds of mathematics many of the mathematicians of the country thought suitable for these levels. At the same time, this mathematics was to be presented in a form that was immediately practical for classroom use. SMSG does not feel that the curriculum displayed in its textbooks is the only suitable curriculum or the best possible curriculum. It is simply a sample curriculum, which the participants of the writing sessions believe is a good one. It is their conviction that individual writers can and will modify and improve the SMSG sample textbooks. Furthermore, they believe that every effort should be made to present to the mathematical community other proposals for curriculums, which may be oriented from entirely different points of view. As a case in point, SMSG has written two separate versions of its tenth-grade geometry course, each of which presents the topic from a different point of view. The Group views the mathematics curriculum as properly a dynamic entity.

The extent to which SMSG has succeeded in influencing the curriculum is perhaps best indicated by the sale, in the school year 1961–62, of 500,000 volumes of its materials. Commercial textbooks of recent publication also bear testimony to the fact that the curriculum reform groups have had an impact upon the mathematics training which will be afforded America's younger generation for at least a nominal period in the future. Many excellent and genuinely new offerings are appearing on the market. SMSG looks forward to the time when it can terminate the sale of its own sample textbooks in the full knowledge that they are no longer needed.

As soon as work was well under way on a sample curriculum for the college-capable students, SMSG turned its attention to a larger segment of our school population, students ostensibly less able to master the material embodied in the SMSG sample textbooks for the college-capable. Statements to the effect that "average" students —that is, those students in the twenty-fifth to seventy-fifth percentile ability range—cannot profit from a study of algebra and geometry are commonplace. However, such assertions seem to have very little factual data to substantiate them. SMSG, while trying to expedite the upgrading of mathematics in our schools, has never lost sight of the fact that there are many questions to which we do not yet have answers. Among these is the one of just how much mathematics students at any given ability level can learn. Recent studies of correlations between performance on achievement tests in the subject matter of some of the newer programs in the physical and biological sciences as related to classical measures of aptitude (generally IQ scores) seem to indicate that many of the so-called less able students are capable of far greater achievement than has hitherto been suspected.

As a first step in an attempt to improve the mathematics training offered our "average" students, SMSG elected to test the hypothesis that these students can learn the kind of mathematics contained in the SMSG seventh, eighth, ninth, and tenth grade texts for college-capable students, provided the material is presented in a less formal fashion, is illustrated with more concrete illustrations, and provided the students are allowed to proceed at a suitably slower pace. It should not be inferred that the question of precisely what constitutes appropriate content for the mathematics training of the students in this specific ability level is being begged by this procedure. Study in this area is still continuing. In light of the very real difficulty involved in trying to predict the future mathematical needs of those who constitute the main bulk of our citizenry, it was felt that, if possible, the most appropriate content would be that which lends itself to the widest number of applications, and which provides the greatest insight into mathematical situations of a variety of types. In the opinion of those of the Group concerned with this problem, the material in the earlier SMSG sample textbooks meets these specifications. It remains to be seen whether it is possible to adapt the material in such a way that the concepts and skills involved fall within the reach of all in this new population. While work is still going on, early results from SMSG field tests show that such a presentation is quite effective, and well within the reach of many in this ability range. A series of new SMSG sample textbooks designed for this purpose was available for general use for the first time in September of 1962.

In 1960, SMSG turned to the elementary school and began a critical study of the mathematics curriculum from the point of view of: increased emphasis on concepts and mathematical principles; the grade placement of topics in arithmetic; the introduction of new topics, particularly from geometry; and supplementary topics for the better students. This work is being undertaken cooperatively by mathematicians, psychologists, specialists in elementary school mathematics, and experienced elementary school teachers.

There is a particularly pressing need for research at these early grade levels. The elementary school years are almost certainly where most children acquire, for better or worse, whatever attitudes they have toward mathematics, and it is quite likely that where psychological blocks to learning mathematics exist, they are formed during these years. There are many unanswered questions surrounding the problems here. How do children learn mathematics? What do they forget and why? Precisely where, why, and how do they acquire the attitudes toward mathematics that they do acquire? What effect does a negative attitude toward mathematics exert on the ability to learn mathematics? Reliable answers to these and similar questions would have a pronounced effect on mathematics education from the kindergarten to the post-graduate university level.

While SMSG is currently engaged in seeking some of these answers, it is also moving ahead in the area of course content for grade levels kindergarten through six. A considerable amount of progress has already been made. Sample SMSG textual materials are available for grades four through six, and experimental materials are being tried out for classes from the kindergarten through the third grade. These materials seek to exploit the children's intuition, and at the same time strive to give meaning to the many routine manipulations of symbols involved in computation. Simple but powerful number patterns are exhibited to the children, and every effort is made to see that they become aware of and can use these patterns to advantage. As one example, the concept of commutativity is developed very early. The children are taught that if they know that the sum of 2 and 7 is 9, then they also know the sum of 7 and 2. There are all too many cases in evidence today where a child, when asked for the sum of 2 and 7, will reply "nine," but when asked for the sum of 7 and 2 will reply, "We haven't studied the seven's yet!" This is even more prevalent with respect to the multiplication tables.

This is but one of the kinds of concepts that almost certainly belong among the children's first mathematical experiences. The SMSG experimental materials seek to exploit these concepts, to use them to help the child cut through the morass of rote memorization that all too frequently comprises their introduction to mathematics. While knowledge of facts is certainly necessary if children are to compute accurately and rapidly, it is not the be-all and end-all of arithmetic, and under no circumstances should it be accepted as a substitute for understanding and applying number concepts. In fact, a clear understanding of the properties of the numbers with which they are working will very likely result in an improvement in the children's ability to recall things like "seven times two is fourteen."

The SMSG elementary school materials also offer an introduction to very simple geometric ideas. Points, lines, and plane figures are discussed, and the children are led to discover some interesting and useful properties connected with these things. Again, the treatment is almost entirely intuitive. The geometric line is then used as a "number line" and offers a bridge between geometric and numerical ideas, one the students will continue to use as long as they pursue the study of mathematics.

While many of the topics covered in SMSG sample textbooks at all grade levels are not really new to the school curriculum, there are some new topics. This, together with the fact that the whole subject is approached in a new spirit and from a new point of view, creates extremely serious problems in the area of teacher training. The pre-service training of teachers is considered properly a concern of the Committee on the Undergraduate Program (CUPM) of the Mathematical Association of America, but SMSG is vitally interested in the in-service training of working teachers. The need for some kind of help here is patent. The number of junior and senior high school mathematics teachers in the United States who are poorly prepared to teach mathematics is staggering. It has been estimated by some to be more than half of the total number of such teachers. Many of them have never completed a course in the calculus. Some have been pressed into the field from other subject matter areas to help cope with the problem of an increasing number of students and a decreasing number of qualified teachers.

The situation at the elementary school level is of even greater concern. Elementary school teachers have never been trained as subject matter specialists. Their education has always been broad in scope, with a significant proportion of their college training devoted to professional courses in the theory and practice of teaching. It is quite possible in some states to become a certificated elementary school teacher without having to complete a single hour's work in mathematics—other than courses in methods of teaching the subject—while in college. When this is coupled with the fact that the entrance requirements of many colleges in this country do not require the successful completion of any academic mathematics (algebra and geometry) in the high school, it is evident that a significant number of our working elementary school teachers have not studied mathematics beyond the level of simple arithmetic. Those who have studied mathematics beyond the level of high school geometry constitute a relatively small part of the whole. Moreover, many of these teachers, through earlier unhappy experiences with the subject, fear and dislike mathematics. It is not surprising that this fear and dislike manifests itself later, many times over, in pupils who have absorbed the same attitude, and who may themselves, pass it on to others.

It is clearly fruitless to discuss a revitalization of the mathematics offerings of our schools without, at the same time, considering ways and means of providing badly needed training to our corps of teachers. College mathematicians have for some years been working hard to alleviate this situation. Aided by NSF funds, they have offered many summer and academic-year institutes designed to upgrade the mathematical qualifications of junior and senior high school teachers. Regrettably, such efforts have not extended to elementary school teachers, and even at the secondary level have not yet been able to reach more than a small percentage of the total number of teachers. One of the more serious problems encountered by those sponsoring such institutes has been the lack of instructional materials appropriate for the purposes and needs of the teachers attending.

After a careful consideration of alternative possibilities, SMSG concluded that it could offer some immediate help to these summer and in-service institutes, as well as to individual teachers, in the form of suitable instructional materials. Accordingly, it began as soon as possible the production of a series of publications called "Studies in Mathematics." These studies are designed to fill gaps in the mathematical backgrounds of many teachers, both at the secondary and elementary school levels, and deal particularly with those topics involved in the curriculum reform movement that have not in the past been included in the normal subject matter training of teachers.

Because the in-service teacher training problem is most crucial at the elementary school level, SMSG is making an especially heavy effort to produce materials for these teachers. In addition to "Studies in Mathematics" designed particularly for elementary school teachers, SMSG hopes to make a contribution to their in-service training through the use of motion pictures and programed auto-instructional material.

The production of basic textual material for students and the provision of aids for the in-service training of teachers, however, are only two of many aspects of the work of SMSG. The Group has also undertaken the production of a series of monographs designed to disseminate good mathematics at the secondary school level to supplement classroom work. These publications are designed to awaken interest among gifted students by presenting mathematics as a satisfying, meaningful human activity. Each monograph is written by an outstanding mathematician, and deals with a topic such as inequalities, transfinite numbers, calculus, or irrational numbers, which is not normally explored in detail in the usual high school mathematics courses. High school teachers read each of the monographs carefully before it is published to insure that its contents will be within the reach of the audience for which it is intended.

Other projects currently being undertaken by SMSG include the production of a series of small publications for supplementary classroom instruction at the junior and senior high school levels. These may be gleaned from material already in the hands of the Group, or else written especially for the purpose. SMSG has also undertaken the translation, into Spanish, of its sample textbooks for grades seven through nine, for the use of the Spanish speaking peoples of Puerto Rico, or any other places in the United States and its possessions where there exists a language barrier to the learning of good mathematics.

The critical need for research in the field of mathematics education has been mentioned earlier in this chapter, and SMSG will henceforth be engaging in an increasing amount of this kind of work. For example, in September, 1962, SMSG embarked on a massive five-year longitudinal study of the effects on students of various mathematics curricula. Two earlier short-term studies, one conducted by the Educational Testing Service and one by the Minnesota National Laboratory, had shown that students of SMSG materials can and do perform as well on tests of the traditional manipulative skills as students in traditional classes, but in addition, master many concepts not included in the regular curriculum. Measuring the degree to which students comprehend these concepts requires new and radically different tests. The five-year study will be much broader and deeper in scope than these earlier efforts. It will involve a very large number of students in a wide variety of schools and school districts, and will deal with several different mathematics curricula. The data obtained can be used, on the one hand, by teachers, school administrators, parents, and other persons interested in evaluating the new mathematics curricula, and, on the other, by those who may wish to undertake further curriculum improvements in the future. The study will be a cooperative effort on the part of psychologists, mathematicians, teachers, and mathematics educators.

Concurrently, SMSG is conducting research into the effect of pupil and parental attitudes toward mathematics on the learning of mathematics. The existence of negative attitudes toward mathematics is a commonplace in our society. Although the extent to which such attitudes prevail is uncertain, it is unquestionably large. The serious implications of these attitudes is frequently overlooked. The loss to our society of capable scientists and mathematicians through the early acquisition of a dislike for mathematics should, alone, be of concern to all of us. More serious than this, however, is the effect such attitudes may have on a citizen who is constantly asked to make decisions involving the future welfare of our nation, when these decisions are all too frequently comprehensible only in mathematical terms. These kinds of decisions seem destined to become more numerous in the future. The isolation and eradication of the causes of such negative attitudes would be of benefit to the whole country.

SMSG is also presently conducting an intensive study of programed instruction in mathematics. The recent upsurge of interest in autoinstructional methods of learning has raised a host of questions about ways to use programed materials and about their place in the educational scheme generally. As a first step in evaluating their effectiveness in mathematics education, SMSG has undertaken a large-scale one-year study using both linear and branching type programs in a variety of situations.

The reception accorded the work of SMSG by various interested groups has been quite gratifying. The students who have studied SMSG materials, for example, have reacted very favorably. Their teachers report that they seem more interested in studying mathematics than they have before, and that classroom sessions are very stimulating and challenging to teacher and student alike. Given a choice, by far the larger part of these students state that they would prefer to continue studying mathematics from SMSG materials. Of course, we do not yet know whether this favorable response results from the SMSG presentation being intrinsically more interesting or whether it is simply a result of its being different from the course work to which they are accustomed.

On the other hand, it seems very safe to say, that teachers consider the materials intrinsically superior to those they have been teaching in the past. Not only do the SMSG files reflect this attitude, but reports from teachers using SMSG materials, both in the professional literature and at professional meetings, indicate the same thing. Most teachers who have taught from SMSG textbooks have had their viewpoints toward mathematics irrevocably changed, and will never return to teaching the same course from the conventional point of view. It should not be inferred that all teachers using SMSG textbooks agree that everything in them is beyond improvement, or that they wholeheartedly endorse every topic included. Teachers have never felt this way toward any textbook or series of textbooks, and no doubt never will. But it is very clear that almost all of the teachers who have used SMSG textbooks look upon them as presenting significantly better mathematics, in a much more meaningful manner, than those which they have formerly used.

Another group with a clear interest in the work of SMSG is the parents of the school children in this country. Reactions from parents have been mixed but, on the whole, indicate approval. One of the most frequent complaints of which SMSG is aware is that parents can no longer help their children with their homework, and this is a particularly shattering experience when the children are in elementary school. Some school districts, when embarking on a curriculum alteration involving the use of SMSG materials, have found it useful to conduct classes especially for parents at the same time. These classes have served to allay the trepidations of most of the parents attending, who, once they are aware of the nature of the new material, quite frequently become staunch supporters of the program. Such classes, however, are the exception rather than the rule, and the problem of informing parents about the need for a reformed mathematics curriculum remains a formidable one. SMSG periodically publishes a Newsletter, each issue of which deals with one or more phases of its work. Although these Newsletters are free, the list still does not contain many names of parents as such. All that is required to receive them is a postcard request sent to:

SMSG
School of Education—Cedar Hall
Stanford University
Stanford, California.

A community of informed and interested parents can be a most valuable asset in any attempt to improve the mathematical offerings of a school or school district.

School administrators form another group of persons interested in the activities of SMSG. In a very real sense they are the most important group of all in any movement to reform the mathematics curriculum, for they are the ones who determine, administer, and are directly responsible for it. SMSG has encountered some rather paradoxical reactions from this group. A few administrators have charged SMSG with attempting to establish a national curriculum, despite the fact that SMSG has repeatedly said that its sample textbooks are just that, samples. The Group has never made any attempt to force its opinions or its products on any school district which does not desire them, nor will it ever do so. The needs of the many local school populations in this country are so diverse, and the individual differences of our young people so pronounced that, in the Group's opinion, the installation of a single mathematics curriculum for all students in all schools of the United States would be a grave mistake.

On the other hand, SMSG has frequently had to face problems arising when administrators have tried to move too fast in incorporating SMSG materials into their programs and have not first made sure that their teachers were prepared to handle them. While such precipitant action sometimes springs from "bandwagon" attitudes, it more often is the result of sincerely held convictions, in this case the conviction that an improved mathematics curriculum was long overdue.

Whatever the motivation, it is manifestly unwise to attempt to install a new kind of mathematics in a school where the teaching staff is not prepared to teach it. The inevitable result will be a disappointed administrator, a frustrated faculty, and a confused student body. While some schools in the country can successfully install SMSG materials almost overnight, many others are not in a position to do so until some attention has been given to the in-service training of their teachers. It is clearly in the interests of all concerned that any alteration of the mathematics curriculum in a school be carefully planned before it is implemented, and that the mathematics teachers in the school take an integral part in the planning.

A fifth group interested in the work of SMSG is the mathematicians. They were, after all, responsible for its formation. It has been said that mathematicians resemble French politicians in the passion with which they hold convictions as to how mathematics ought to be taught. The relatively small number of objections to what SMSG has done is, therefore, a tribute either to the well-publicized statement that SMSG is preparing only a sample program, or else to the general acceptability by the mathematicians of the results. The only serious objection to SMSG textbooks that has been agreed upon by more than a handful of individuals is concerned with applications of mathematics. It is true that applications of mathematics are not the chief concern of SMSG textual material, although they are discussed frequently. The reason for this is quite simple; there are many different applications for almost every mathematical concept. It seems of overriding importance that the concept involved be clear if the student is to be able to apply it in any one of a variety of situations. The examples that are scattered throughout the textbooks, therefore, come from a wide assortment of situations; physics, chemistry, biology, business, and consumer problems are all in evidence.

There are some who feel that if mathematics is not continuously tied to physical models, it will not be understood, and will not be appealing to the student. This is, of course, one point of view, and it is a point of view that was represented by some of the writers of the SMSG texts. The fact that it is not a point of view that is widely shared by mathematicians is evidenced by the fact that not all of the mathematics included in the SMSG textbooks is explicitly motivated by, or developed around, physical situations. It was the feeling of the writers of SMSG textbooks that, contrary to the belief of some, not every teenager is fascinated by the behavior of freely falling bodies, or enthralled with phenomena exhibited by gasses in closed or leaking containers. When, in the opinion of the school teachers involved, physical motivation seemed indicated, it was included; when they felt it would serve no useful educational purpose, it was not. Nevertheless, to persons who are dedicated to the thesis that ideas, as such, are of little interest or concern to anyone, it may seem that SMSG has done less than justice to their particular school of thought. The Group believes, however, that it has achieved a reasonable balance in this regard, considering the very wide variety of mathematical viewpoints represented among its writers.

Commercial publishers, as a group, are also very concerned with the activities of SMSG. A number of texts have recently appeared through normal commercial channels written along lines advocated by SMSG. SMSG has never had any desire to compete with anyone, either in the sale of its books or in the promotion of its program or in the establishment of an orthodoxy. It is solely concerned with upgrading the mathematical training of American school children. Because there have not been suitable textbooks available, SMSG has felt obligated to furnish to those school districts who wished to modernize their curriculum the textual material necessary to do this. Such action was essential if the Group was to achieve the objective it was committed to achieve. To have done otherwise would have been to establish a need that no agency, public or private, could have met. The time has now come when SMSG can re-evaluate the textbook supply situation and, indeed, is in the process of doing so. When, in the opinion of its advisory board, there exist on the market commercial textbooks of comparable mathematical quality in sufficient numbers to meet the needs of the schools, it will cease reprinting its sample textbooks. It hopes that the time when it can do this in good conscience is not far distant.

Every individual associated with SMSG feels privileged to be taking part in one of the most important educational movements of the past half century, the modernizing of the school curriculum as it applies to mathematics and the sciences. It seems safe to say now that such contributions as they have made balance out on the positive side. In particular, there are two of major importance. First, SMSG has demonstrated that children can learn a much better brand of mathematics than has hitherto been offered them. And second, it has proven that classroom teachers and ivory-towered mathematicians can work together amicably and productively. In the future, SMSG hopes to continue to exploit the second in order to provide better material for the first.

4

The Math Wars

BENJAMIN DEMOTT · AMHERST COLLEGE

The issues in the dispute seemed at first glance impenetrable, but the sequence of events that brought them public notice was easy to trace. In October, 1961, the New York University *Alumni News* carried an article by a faculty member abusing proposals for the improvement of secondary school mathematics teaching that had recently been put forward by three major professional groups of mathematicians. The article, several thousand words long, was given a front-page play beneath the headline, MATH TEACHING REFORMS ASSAILED AS PERIL TO U.S. SCIENTIFIC PROGRESS; it was picked up by alert education editors and wire services; within days the *Alumni News* was reprinting it in batches of 1500 in an attempt to keep up with requests for copies that poured in from parents, teachers, principals, superintendents, professors and college administrators everywhere in the country. (The superintendent of schools at Lindenhurst, Long Island, asked for twenty copies, one for each member of his mathematics department; the Rutgers Graduate School of Education distributed 150 copies; a professor at the University of Pennsylvania ordered sixty copies, announcing that he meant to send one to every school superintendent in suburban Philadelphia.)

A counterattack was quickly launched by the abused organizations. Individual leaders of the three groups, including professors at Stanford and at the Universities of Chicago, Minnesota and Kansas, wrote strong letters of self-justification that appeared in the metropolitan dailies as well as in a later issue of the *Alumni News*. The

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parent professional body, the National Council of Teachers of Mathematics, released for national circulation a ninety-page account of the more important ventures in the "improved mathematics" field—and this pamphlet itself became the subject of bewildered wire service dispatches. By the end of the year confusion had mounted so high that mathematicians were under pressure to gather themselves for the labor of public clarification. "It's getting so that the layman no longer knows what expert to listen to," said the *Newsletter* of Admiral Rickover's Council for Basic Education. And other organizations joined this one in calling for a "calm discussion of the issues, couched in non-technical terms and addressed to the general public as well as to school people."

The likelihood that the call would quickly be heeded appeared slight. For one reason, too much intemperate language was shed by the principals of the dispute to permit a docile retreat into mannerly talk. (Professor Morris Kline, the author of the *Alumni News* article that roused the original furies, described aspects of the improved mathematics programs as "wholly misguided," "sheer nonsense," attempts to replace the "fruitful and rich essence of mathematics" with "sterile, peripheral, pedantic details." And Professor E. G. Begle of Stanford, one of the mathematicians who responded to this attack, accused Kline of laying down an indictment without supporting evidence, and ended an angry letter with the inelegant remark that it was "time for Prof. Kline to either 'put up' or 'shut up.' ") For another, the teachers and professional mathematicians involved in the programs under abuse obviously regarded themselves as unselfish patriots, men who willingly interrupted their careers for an enterprise in public service and hence had some right to immunity from criticism that appeared to disparage their motives. And for still another the dispute in question was not really of recent birth: it had begun exacerbating feelings in professional circles years ago, with the result that certain lines of division had already hardened in a manner inimical to calm or friendly discussion.

To say this is not to imply that well-defined antireform factions exist at this moment within the groves of academic mathematicians. Professor Kline stands as the spokesman for hosts of doubters—superintendents, parents and others—but no professional group as yet has endorsed his views. Indeed, professionals in his field seem strikingly unified in their support of projects of teaching reform. The Commission on Mathematics of the College Entrance Examination Board and the Secondary School Curriculum Committee of the National Council have worked together from the inception of the movement. At least six projects of improved mathematics are already in full tide, publishing new textbooks, retraining high school teachers, educating civic organizations on procedures for instituting curriculum reforms in their local school systems. (Among the most active groups are the University of Illinois Committee on School Mathematics, the University of Maryland Mathematics Project, the Ball State, Indiana State Teachers College Experimental Mathematics Program and the Boston College Mathematics Institute.) Improved mathematics programs have been sponsored by state offices of education—witness the Minnesota Laboratory for the Improvement of Secondary School Mathematics. And the Federal Government itself, acting through the National Science Foundation, has contributed over four million dollars to the School Mathematics Study Group (S.M.S.G.), which already has drawn on the labors of hundreds of school and university mathematicians in devising its new curriculum.

Since S.M.S.G. ranks as the largest united effort for improvement in the history of mathematics education, it has borne the brunt of Professor Kline's attack. The project is now four years old. It had its origins in the spring of 1958, when the president of the American Mathematical Society appointed a committee to seek methods of improving the teaching of high school mathematics. The head of the committee was the author of the "put up or shut up" letter just mentioned—Professor Begle, then of Yale, now of Stanford. His group had the guidance of an advisory council composed of college and university mathematicians, high school teachers, experts in education and representatives of science and technology; and, as already indicated, it had the financial support of the National Science Foundation. The Committee's initial decision was that the weakness of mathematics teaching in high schools was at least partly attributable to the tendency of the mathematics classroom to focus on mere mechanical manipulation of numbers in accordance with rote-learned rules, instead of upon studies that induced a conception of the meaning of the rules and the manipulations. It was convinced that twentieth-century advances in mathematics had not only clarified the *nature* of mathematical knowledge, but had produced ideas that could be introduced into secondary school education for the purpose of effecting the desiderated shift in focus. And it assumed that the best way to insure the orderly introduction of these ideas was to create a series of texts for a complete six-year mathematics course in junior and senior high school.

Accordingly, the Committee set itself the task of producing the required texts. It assembled a staff of about a hundred university mathematicians and the same number of high school teachers; the staff was divided into writing teams (composed equally of high school and university teachers); within a year the first texts and teachers' manuals were completed. These were put into use in the school year 1959–1960 by 400 teachers instructing 42,000 pupils in forty-five states. (They are in much wider use now.) The secondary school teachers in the experiment were guided by consultation with university mathematicians—sometimes by "in-service courses" given in the high schools themselves. The textbooks were evaluated through analysis of questionnaires concerning them that were answered by teachers, pupils and outside advisers; they were then extensively revised by a staff of a hundred practicing teachers organized into revision teams, and thereafter put on the market at cost by Yale University Press. The latter has also made available an accompanying series of so-called "enrichment pamphlets"—attractively written surveys of special subjects in mathematics designed to encourage gifted students into deeper explorations of the topics treated in their current S.M.S.G. texts. (These pamphlets are comparable in purpose, although not in content, to the series of Russian texts recently brought out in translation here by a division of Random House: six books treating topics of interest in the history of mathematics that are offered to talented Soviet secondary school students as supplements to their regular textbooks.)

The timetable thus described, which suggests that the S.M.S.G. texts were hastily produced and tested (Professor Kline himself has made this charge), is to a degree misleading. Although the organizing committee of S.M.S.G. was formed only in the spring of 1958, discussion of ways of improving mathematics teaching was well-ad-has endorsed his views. Indeed, professionals in his field seem strikingly unified in their support of projects of teaching reform. The Commission on Mathematics of the College Entrance Examination Board and the Secondary School Curriculum Committee of the National Council have worked together from the inception of the movement. At least six projects of improved mathematics are already in full tide, publishing new textbooks, retraining high school teachers, educating civic organizations on procedures for instituting curriculum reforms in their local school systems. (Among the most active groups are the University of Illinois Committee on School Mathematics, the University of Maryland Mathematics Project, the Ball State, Indiana State Teachers College Experimental Mathematics Program and the Boston College Mathematics Institute.) Improved mathematics programs have been sponsored by state offices of education—witness the Minnesota Laboratory for the Improvement of Secondary School Mathematics. And the Federal Government itself, acting through the National Science Foundation, has contributed over four million dollars to the School Mathematics Study Group (S.M.S.G.), which already has drawn on the labors of hundreds of school and university mathematicians in devising its new curriculum.

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Accordingly, the Committee set itself the task of producing the required texts. It assembled a staff of about a hundred university mathematicians and the same number of high school teachers; the staff was divided into writing teams (composed equally of high school and university teachers); within a year the first texts and teachers' manuals were completed. These were put into use in the school year 1959–1960 by 400 teachers instructing 42,000 pupils in forty-five states. (They are in much wider use now.) The secondary school teachers in the experiment were guided by consultation with university mathematicians—sometimes by "in-service courses" given in the high schools themselves. The textbooks were evaluated through analysis of questionnaires concerning them that were answered by teachers, pupils and outside advisers; they were then extensively revised by a staff of a hundred practicing teachers organized into revision teams, and thereafter put on the market at cost by Yale University Press. The latter has also made available an accompanying series of so-called "enrichment pamphlets"—attractively written surveys of special subjects in mathematics designed to encourage gifted students into deeper explorations of the topics treated in their current S.M.S.G. texts. (These pamphlets are comparable in purpose, although not in content, to the series of Russian texts recently brought out in translation here by a division of Random House: six books treating topics of interest in the history of mathematics that are offered to talented Soviet secondary school students as supplements to their regular textbooks.)

The timetable thus described, which suggests that the S.M.S.G. texts were hastily produced and tested (Professor Kline himself has made this charge), is to a degree misleading. Although the organizing committee of S.M.S.G. was formed only in the spring of 1958, discussion of ways of improving mathematics teaching was well-advanced by that time. The Carnegie Corporation and the University of Illinois, for example, had been jointly supporting a Curriculum Study in Mathematics since 1952; the Study had produced a number of texts emphasizing (as those of S.M.S.G. were to do) the structure of mathematics and the "discovery theory" of learning; these texts had been tested in several states before the S.M.S.G. project was undertaken. By 1957 the Commission on Mathematics had circulated to secondary schools and universities thousands of copies of a detailed series of recommendations for teaching reform. Discussion of these recommendations, including presentation of papers surveying them at learned society meetings and public debates on their merits at various state universities, had been fully reported to the profession as a whole by the spring of 1958, when the N.S.F. agreed to support a comprehensive national program of reform. Indeed, Professor Kline himself was in print with an attack on the theories of the reformers as early as October, 1958, before any S.M.S.G. textbook had been completed. Although in the last four years he has written often in opposition to "the modernists," as he calls them, he acknowledged a few months ago that their assumptions were familiar enough in 1958 for him to write an article about them at that time that in substance is still his position. There is, in short, some reason for hesitating to accept this critic's recent complaints about "helter-skelter" preparation, or his ironic observation that "apparently one year of experimentation, and a revision executed as hastily as the original, sufficed to determine the ideal curriculum for an entire nation."

These complaints, however, are by no means central to the case that Professor Kline has made against the curriculum in question. That case is built on a rejection of four key assumptions of the reformers. The first, as Professor Kline represents it, is that a revolution in mathematics has occurred in the last sixty years that has rendered obsolete the mathematics that is now being taught in secondary schools. Professor Kline scoffs at this assumption, arguing that the revolution is largely a fiction, that "if there is one subject in which up-to-dateness is totally irrelevant, it is mathematics," and that the reformers disprove their own contention that the mathematics of the past is outmoded by including a large measure of it in their new texts. The second assumption of the reformers that Professor Kline rejects is that the new topics to be included in the secondary school curriculum—symbolic logic, Boolean algebra, set theory, groups and fields, postulational systems and statistics—are of vital importance partly because of their practical applications, partly because of their power to illuminate standard mathematical topics. Professor Kline's answer to this point is that "one could not pick [material] more peripheral" to "the body of mathematics" than the new topics, and in any case these topics are almost bare of applications in science—"practically useless." The third assumption of the reformers is that, quite aside from their practical reference, the new topics are of especial use in helping teachers to present standard material from a unified point of view. Professor Kline dismisses this claim with the remark that a student might well come to an understanding of "unity," might fathom (say) all the operations, properties and laws of a field, and still be unable to "add 2 and 2" —much less fractions, irrationals or complex numbers. And the fourth assumption of the reformers (once again, as Professor Kline represents it) is that the best way to arouse interest in mathematical ideas is to develop a student's instinct for abstraction. Professor Kline counters this claim by offering his own pedagogical philosophy. Its chief article is that student interest can only be wakened by teachers who constantly emphasize that the primary use of mathematics is "the solution of simple, genuine, and basic physical problems," and who invariably present concepts "intuitively in physical or geometric terms." When abstraction enters, when the teacher cannot demonstrate "applications," when mathematics that can be related to physical phenomena is replaced by "pointless mathematics, a manipulation of meaningless symbols," then (says this critic) the mathematics classroom becomes a place "which can appeal only to an esoteric group."

As might be guessed from the publicity given these arguments, the man who developed them is a professional of substantial qualifications. He is chairman of the Washington Square College (N.Y.U.) mathematics department, and director of elctromagnetic research at the University's Institute of Mathematical Sciences; he has spent two years in research at the Institute for Advanced Study at Princeton; he has held Guggenheim fellowships; he has expressed his hostility to the notion of mathematics as pure abstraction in two recent and interesting books, *Mathematics in Western Culture* and *Mathematics in the Physical World*. What is more, he is a lively writer: noting that the "modernists" justify the teaching of Boolean algebra on the ground that it is used by designers of switching circuits, Professor Kline once observed: "The claim is technically correct, but it justifies teaching Boolean algebra to high school students about as much as the argument that the Presidency of the United States is important because it publicizes the game of golf." Equally important for the future of the reform movement, he is a skillful public debater. According to report he has often bested opponents in debates on the new mathematics held at professional association meetings; it is said, in fact, that the modernists are now engaged in a search—with an eye on the next convention of their tribe—for a man who can match Professor Kline's agility and spontaneity on the platform.

That the cause of "improved mathematics" would be helped if the search succeeded is unquestionable. But it does not follow from this that professional mathematicians stand in serious need of a sage to define for them the fundamental issues in the dispute. A full view of these issues, to be sure, would include many subtleties and qualifications. It is plain that the new mathematical topics are not wholly remote from life. They can even be treated as responses to the technological complexity of modern society—that which replaces the clerk on his stool at his ledger with the electronic digital computer, that which in manufacturing enterprises adds to the familiar calculations of profit and loss the unfamiliar calculations of quality control. It is also plain that twentieth-century mathematics does have applications in the expression and investigation of physical phenomena unheard-of until recently—Lorentz transformations, new series of elementary particles, quanta, nuclei, mass-energy equivalence. And yet those who cite such connections and applications—as for example Professor G. Baley Price of the University of Kansas, who in late 1960 put a lengthy case for the practicality of the new mathematics before an N.S.F. Conference—cannot quite persuade their audience to think of Boole as plain brown bread. Professor Kline does have fact on his side when he claims that the major areas of mathematical applications remain those of mechanics, sound, light, radio, electricity and the like, or when he observes that the mathematics required in these fields is largely the old staple stuff, from algebra through the theory of operators, or when he taunts his enemy with the assertion that for every ten people in the world working with applications of Boolean algebra, there are a hundred thousand working in traditional fields. But, to repeat, although there are qualifications to be entered on both sides, the major issues are in no real sense obscure to the trade. Most mathematicians have had enough experience with differences of this kind to recognize that the dispute is at bottom only another version of the old quarrel between the engineering and the scientific mind, between "applied" and theoretical intellects.

And by the same token, turned to the obverse side, no practicing mathematician needs a sage to teach him either that the advance of mathematics has been, historically, toward higher levels of abstraction, or that again and again this seeming movement away from experience paradoxically has led deeper into some portion of reality. Professor Marshall H. Stone of the University of Chicago, a major American mathematical intelligence, undertook recently to state the strongest possible case for abstraction in his field. (The essay in question appeared in the May, 1961, issue of *Liberal Education.*) Opening his argument with the assertion that the twentieth century had in fact created a new mathematical world, he wrote that:

> . . . while several important changes have taken place since 1900 in our conception of mathematics . . . the one which truly involves a revolution in ideas is the discovery that mathematics is entirely independent of the physical world. . . . To put this a little more precisely, mathematics is now seen to have no necessary connection with the physical world beyond the vague and mystifying one implicit in the statement that thinking takes place in the brain. . . . When we stop to compare the mathematics of today with mathematics as it was at the close of the nineteenth century, we may well be amazed to note how rapidly our mathematical knowledge has grown in quantity and complexity, but we should also not fail to observe how closely this development has been involved with an emphasis upon abstraction and an increasing concern with the perception and analysis of broad mathematical patterns. Indeed, upon closer examination we see that this new orientation, made possible only by the divorce of mathematics from its applications, has been the true source of its tremendous growth during the present century.

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Professor Stone went on to quote Bertrand Russell's famous epigram, "Mathematics is the subject in which we do not know what we are talking about or whether what we say is true," and he approved it as testifying to the abstract and purely formal nature of mathematical truth. And while he acknowledged that some mathematical systems can serve as "models for portions of reality, thus providing a basis for a theoretical mathematical analysis of relations observed in the phenomenal world," he maintained that this kind of connection between reality and systems is "accidental and to a certain extent arbitrary. . . ."

But even in the essay under discussion Stone hesitated to claim that a "divorce of mathematics from its applications" was absolutely desirable everywhere in the curriculum. He addressed himself directly to differences of opinion "about the antithesis between the concrete and abstract or the related mathematical antithesis between manipulation and pattern-discernment," treating them as especially likely to arise in cooperative teaching ventures involving mathematicians and physical scientists. And he remarked that, "since abstraction and the discernment of patterns are demonstrably playing more important roles in the scientific study of nature—as is very strikingly plain in the case of quantum field theory—the mathematician's desire to emphasize the abstract and the structural aspects of mathematics . . . may today begin to be more sympathetically received than was formerly the case." But, having said this, he added forcefully that "the mathematician should not neglect the manipulative aspects of his subject nor insist that his own concern for generality and precision should at all times and in all circumstances be shared by those who engage in making applications of mathematics."

This hesitation—even fence-straddling—may seem surprising: why should a writer end a powerful argument for abstraction as a liberating force with an acknowledgment that awarness of relations between idea and application is at once an obligation and a need? The mystery, however, is more apparent than real. Professional mathematicians know that neither a Kline nor a Stone can attempt to assess his subject, or modes of teaching it, by simple reference to standards that depend upon a dichotomy of idea and application, manipulation and pattern. A tension between these items exists; personal tastes and interests determine individual responses to both; neither can be thought of as something to be "rejected."

And as for the possibility that the reform movement may stand or fall on its ability to turn up an orator who can dramatize the claim that a revolution in mathematics has occurred in the last sixty years: there is little to be said here save that in the history of thought one man's revolution is usually for many years other men's nonsense. In intellectual history revolutions equal states of consciousness. At this moment many sensitive, knowledgeable literary minds are certain that the study of the writings of Freud has nothing whatever to do with the study of Shakespeare, and that a man who allows Freud or Frazer or another intruder from "social science" to corrupt his reading of a poem or play is simply a victim of cant. You cannot *prove* revolutions in any subject; you can only argue that a certain idea ought to have the effect of altering the meaning of the past. Revolutions can be said to have "occurred" only when the meaning of the past has been altered in the common consciousness, only when private intuitions about change have become public assumptions. In the world of mathematics that day has not arrived—and until it does, it will be impossible to measure the worth of a teaching program by considering its adequacy to an "intellectual revolution."[1]

The truth is, of course, that the one sound test of the improved mathematics movement is whether it offers the student of algebra or geometry or coordinate geometry a more stimulating and exciting vision of his subject than he hitherto has been offered—whether, in short, it can arouse in him that odd sort of infatuation that in intellectual affairs leads to responsible intensities and sober marriages. Judgment on the question must be comparative, and for those who do not live from day to day with mathematics this means hunting up standard mathematics texts and comparing relevant sections of them with the reform movement texts. An unprofessional eye that ventures on a task of this kind begins it in irritation, but it must be said in the present instance that the irritation gives way rapidly to pleasure. The new texts do not wholly eschew techniques leading to intuitive understanding of certain themes—but the themes taught *are* mathematical themes, items that cast light not on pencils and nickels (5 × 5 means five nickel candy bars cost a quarter), or on the endless neutral intercourse of x and y, but instead on the very ideas of relatedness, multiplicity, intellectual motion itself.

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[1] Professional mathematicians have made several interesting efforts in this line, however. The best of them, a genuinely helpful survey of relations between the new mathematics and the new curriculum, is an essay by Albert E. Meder of Rutgers called "Modern Mathematics and Its Place in the Secondary School" (*The Mathematics Teacher*, October 1957).

It is not simply that the new texts seem throughout to have abandoned old-line priggishness about admitting that symbols are symbols—although the freedom and playfulness of the acknowledgment is delightful (numbers are names for orderly relations; $5x^2 + 3$ over $5x^2 + 3$ is a name for 1; other names for orderly relations are endless). Neither is it simply that the new texts, as for example the S.M.S.G. first-year algebra book, boldly introduce the notion of the "set" on opening day—so that from the first the student is introduced to the possibility that the models, the numbers and letters he mechanically manipulates, are of less interest than the ideas that these mechanical operations express.

It is, rather, that the texts everywhere invite the student to understand mathematics as at once an area and a mode of thought—not as a clutch of senseless rules and problems that either do or don't "come out." An ordinary old-line algebra text is likely to begin with flat definitions: "Addition and multiplication are *commutative.* This means that numbers may be added in any order or multiplied in any order without altering the result. ($3 + 5 = 5 + 3 = 8$; $5 \times 3 = 3 \times 5 = 15$.)" S.M.S.G. algebra moves quickly to a consideration of the ideas of sequence and process. It develops its examples of the commutative property not simply with numbers but with symbols standing for numerical oddness and evenness (and for certain sequences of operations that can be performed with certain results in oddness and evenness). From here it moves at once to symbols expressing sequences of turns and half-turns, and at length to patterns of progression involving relations among triangles and circles. The student is eased gently aloft from mechanical manipulation of numbers through a succession of patterns to a perception of commutative property that does not depend upon the model of number, that involves a feeling for the qualities of contrived relations, and that as a consequence swiftly thrusts him in contact with the flash, dance and fluidity of a genuine although simple mathematical idea. Doubtless it would be a mistake to claim that the reformers of mathematics teaching are engaged in one more attempt to draw minds closer to an intuition of experience as process and relation, rather than as collected objects forever waiting to be assigned as someone's homework. But it is not extravagant to say that, for a reader whose study of mathematics lies in the past, an evening with an S.M.S.G. text is an exhilarating experience—a release from ordinary containments into a glistening soundless spinning world where the mind knows paths in pathless air and sails by the still diamond light of invention.

Does it follow from all this that Professor Kline's reservations about the modernists are senseless? Is the man simply to be understood as one who, nervous about altitudes, refuses to fly out of sight of land? Certainly it can be said that Professor Kline's insistence that S.M.S.G. has done nothing but introduce new topics into secondary school mathematics is difficult to accept: the new topics have plainly been *used* to illuminate structure, to demonstrate what the old mathematics was and is about, to dramatize the unity and beauty of mathematical thought. And it can also be said that Professor Kline's enthusiasm for "applications" sometimes leads him into historical overstatement. Few people who have studied the background of Leibnitz's philosophical and mathematical ideas would be entirely satisfied by Kline's statement, in a catalogue of evidence proving that "the primary motivation for mathematics is physical science," that "the calculus was motivated by celestial mechanics." But even after these carping notes have been registered, and the charm of the S.M.S.G. texts has been granted, it must be added that at least one of Professor Kline's strictures is not easy to dismiss.

The reason, as might be guessed, is that even when taught by teachers fond of metaphors appealing to intuitive understanding ("The absolute value of a number is its positive twin sister"), the S.M.S.G. series, like many of the other mathematics projects, is difficult. That is to say, it unrelentingly asks its reader to think, rarely permits him to rest in rote. Most old-line texts are geared to the average student: all students learn rules and mechanical operations, able students simply progress at a faster rate from chapter to chapter. S.M.S.G. texts begin by assuming that students not only can learn to relish higher feats than that of learning a rule and applying it, but indeed can learn how to think in mathematics for themselves. The probability is that anyone who can learn to do the latter can also learn (returning to Professor Kline's argument) how to add fractions. But more than a few who cannot learn how to think in this fashion might learn some mathematics, if they were taught in the traditional manner.

The reformers are not, of course, oblivious to the truth that the curriculum they have devised is more demanding than the present one. The National Council of Teachers of Mathematics itself has admitted that most of the new curricula were designed for "college capable students." (The University of Maryland project has been tried experimentally—and inconclusively—with slow students.) S.M.S.G. texts have thus far been used mainly in classes of above-average students, and they have not been manna to students with inferior "mathematical aptitude." Newton High School in Massachusetts used S.M.S.G. geometry materials in four classes (130 sophomores) in 1959–1960; all students were "unselected except for the fact that they were in the college preparatory curriculum." The head of the school's mathematics department reports that "while our measuring device was probably crude, it is significant that when these students were compared with those in the traditional geometry course, the better students in the new program did better, the poorer students did poorer." In response to this criticism the S.M.S.G. has already prepared seventh and ninth grade texts for slower students; these are being tested and will be revised for use in the fall of 1962.

Until the results of the test are known, the question whether "improved mathematics" texts adapted to low "reading levels" can be effective with ordinary students will remain a question. And that this is a slightly different problem from the one raised by Professor Kline does not mean that it is insignificant, or that Professor Kline's role in bringing it to notice is trivial. It may or may not be true that the N.Y.U. professor deserves thanks for reminding his profession, and the interested public, that however arbitrary and accidental the connections between reality and mathematical systems, society is obliged to consider them important—since there is no definite schedule for the entrance of common men into the promised world of pure mentality. It may or may not be true that his real service was to face men of mind once again with the need to decide when, if ever, the great intellectual "revolutions" of this century should be enacted in the curricula of schools and colleges. But his arguments do bring into focus a key problem of twentieth-century democracy: how to educate men for leadership without dividing society into rigid classes of knowers and hewers. And for this they can be valued.

But not—this is all-important—not to the point at which they assume parity with the labor of the "modernists" they attack. The S.M.S.G. projectors have not thought deeply on the problem of selective education. Their original conception probably was a shade utopian in character: a vision of ideal teachers and ideal students that could not correspond to American (or any other) facts. And they have not yet succeeded in describing, in fully comprehensible terms, their goals and the particular techniques they are employing in the hope of accomplishing them. But they have created instruments with the aid of which many thousands of Americans will come, early in life, to a sense of the light and grace of a world once nastily bound in briars. And beyond this, they have demonstrated that the academic can serve the public interest brilliantly without meeching about the White House. The mathematical projectors chose not to isolate themselves in tight graduate school hives; they were willing to expose their studies and their present modes of thought to the eyes and understandings of humbler teachers and humbler students; they have not hesitated to accept responsibilities that other professionals too often cynically delegate to publishers' drummers or third-rate academic minds. Even if they had failed in the task they undertook, they would for these reasons deserve praise and honor rather than abuse. As it is, they have a claim to a tolerably high rank among the exemplary intellectuals of this age.

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5

The Requirements for Major Curriculum Revision

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In this paper, "curriculum revision" is intended to signify the entire process of the preparation of educational materials for use in the formal school system, or in direct association with the formal school system. It is thus an inclusive term, and in the context of this paper should be distinguished from the more limited activity in which general curricular directives are set forth and their implementation left to others.

Over the past six years, major curriculum revisions have been undertaken in the United States over a wide range of subjects. Early activities were restricted to mathematics and the natural sciences, but more recently revisions have been extended to the fields of modern languages, including English.

The purposes of all these activities are much the same. They reflect, in the first place, dissatisfaction with the gulf that has been permitted to open between the professional scholar or research scientist, on the one hand, and the schoolroom on the other.

This general dissatisfaction has been reinforced by a growing awareness that the capacity of children to learn has commonly been grievously underestimated. Mathematicians particularly have dis-

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An earlier version of this paper was presented to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas.

covered that children by the age of ten years or even less can master extremely subtle concepts, if those concepts are properly presented to them. Investigations over the past ten years have led one psychologist to propose that "any subject can be taught effectively in some intellectually honest form to any child at any stage of development." Even if this statement is broadly qualified, it remains difficult to presume that the gulf between the professional practitioner and the general student is a necessary consequence of the student's incapacity or unreadiness. If any charge of incapacity or unreadiness is to be laid, it must now be upon the professional scholar himself, who has been either incapable of presenting his discipline in an appropriate manner or unwilling to divert himself from his specialized activities to make the requisite effort.

The arousal of fundamental interest in the content of elementary and secondary education is a development of profound significance. Curriculum revision has attracted the participation of professional scholars whose leadership made the recent massive efforts effective. The first such revision to be carried out as a major program on a national scale was that of the Physical Science Study Committee, which began in 1956 and entered the American school system as a complete one-year physics course in 1960. Most later revisions have been patterned to some degree upon that carried out by the Committee. Considerations set forth in this paper reflect the close association of its authors with the Physical Science Study Committee program, and consequently are likely to be drawn from the Committee's experience; they should be taken as applicable to the entire range of curriculum revision to the extent that they are general considerations arising out of general problems.

At least four distinct components can be distinguished in a program of curriculum revision: (a) The process of determining the precise boundaries of the educational unit that will be treated; (b) the process of identifying the subject-matter which is to be dealt with within that educational unit; (c) the embodiment of that subject-matter in material form, as text, laboratory or classroom materials, and other learning aids; and (d) the preparation of teachers in the new subject-matter and in the use of the materials. Of these four components, the first is likely to precede the rest; the determination of subject-matter, its embodiment, and the preparation of teachers must however be carried on to a large degree simultaneously.

The Educational Unit

In an ideal sense, the educational process is a continuum, no portion of which should be treated in isolation from the rest. Yet, such an isolation must be arbitrarily imposed before curriculum revision may be undertaken. The project must be reduced to manageable size if it is to be broached with any confidence and completed in any reasonable period of time. Revision of "education" is not a goal that may be realized directly: rather, it must be approached in terms of revision of mathematics in the early grades, or of English in the secondary school, or some such practical unit.

In the United States, with its wide variety of school systems, each of which is in some degree independent of the others, there is also a compulsion to work in small units. The Physical Science Study Committee, as its name implies, would have preferred to create a two-year course in physics and chemistry rather than the one-year course in physics that it finally produced. Yet, it was necessary to recognize that most American secondary schools, as they are now constituted, would not find it possible to fit a two-year course into their structures. The decision to restrict the revision to physics was made reluctantly, but in practical terms it was the only decision open to the Committee.

The School Mathematics Study Group chose to embark on a revision of mathematics curriculum over a six-year range, which has since been extended to nine years. This was possible only because the Group was able to retain the general structure of mathematics curriculum and effect its changes within that structure. Thus, the School Mathematics Study Group became a group of related programs, each of which worked within an existing structure, rather than a single extensive program of curriculum revision.

It may be protested that this unitary approach leads to a lack of coherence, or at least to a roughness at the seams where units meet. This can scarcely be denied. But with conventional curricula, in the United States at least, the incoherence already exists and, indeed, defies attempts to remedy it. The task of joining a one-year physics course to a one-year chemistry course will surely be simpler when the courses themselves reflect the outlooks of the physicist and chemist, for in those outlooks the coherence is known to exist.

The Determination of Subject-Matter

Two questions must be answered in the course of determining the subject-matter that will constitute the unit under consideration. First, what is it desired that the student learn from the unit? Second, what selection of material and what ordering of that material will make it most probable that he will indeed learn?

There is never a unique answer to the first of these questions. Turning again to physics, one might wish to provide the student with an intimate knowledge of modern technology, or with an acquaintance with the manner in which physics has grown. During the early days of the Physical Science Study Committee, both of these were entered as possibilities and were warmly debated; if either had carried the day, the Committee physics course would be quite different from the course as it now exists. In fact, it was decided instead that the course would be directed toward familiarizing the student with two central notions of modern physics: the wave-particle duality and the modern concept of the atom. Behind this decision was the view that these two notions lay at the heart of the modern physicist's outlook upon his universe, and that it was this outlook that the course should convey.

This answer set boundaries upon the answer to the question of selecting and ordering. If a one-year course was to deal intelligibly with the wave-particle duality and nature of the atom, much that has been conventionally taught as physics would have to be ignored or skimped. Physics is too rich to be taught in its entirety in a single year; the criteria of selection would have to identify those portions of physics which contributed to the elucidation of the wave-particle duality and the nature of the atom.

As a consequence, the Physical Science Study Committee course contains little about sound, or electric circuitry, or relativity. They are omitted, not because they are devoid of interest, but because they are not central to the theme. Instead, the course proceeds through optics and the behavior of light to the kinematics of waves, then to Newtonian dynamics, electric forces and, finally, the atom. All this is told as a continued story, in which each chapter is firmly bound to its predecessor and leads to its successor.

Considerations of this sort are common to all curricular revision. In every academic discipline, scholarship over the last century has reaped rewards so rich that even the most eminent scholars cannot hope to master their subjects in anything approaching their entirety. No student, during his 12 years prior to college, is going to "learn" English literature; at best, he will become reasonably familiar with some small part of it. The task of the reviser is to see that what he learns is appropriate, and that through what he has learned he will be able to grasp the significance of the discipline as a whole.

The Physical Science Study Committee, and secondary-school revisions in general, have also the special problem of dealing with students who in all likelihood will never again engage in formal study of the subjects they encounter in secondary school; the view of those subjects which they gain in secondary school will be the view they carry through life. Clearly this must affect the general decision on subject matter. A course in mathematics for the first grade, where study is clearly preliminary to further study, might well reach an entirely different kind of conclusion. Yet, the process of decision is the same: What would you have the student learn? How is he to learn it? If the subject is French, will he be expected to speak the language or to read it? Will he study French further? Is he to comprehend "Le Figaro" or Villon—or "Le Canard Enchaine"? There is no certain answer to any of these questions; they are matters for decision.

Nor can it be assumed that the selection and ordering of subject-matter will flow unerringly from the decision on purpose. The test of a curriculum lies in the classroom. However ingenious the selection and ordering, they must prove their worth in practice. It must be demonstrated that the student understands and, indeed, employs those elements of the professional outlook which have been presented to him. Classroom experimentation with materials, and the provision of a system by means of which classroom experience can be evaluated and fed back into the process of revision, are basic requirements of any major program of curriculum revision. Without such a feedback system, the program wanders blindly into unknown territory, and is likely to end with a curriculum which in practice accomplishes no part of what it intended.

Production of Materials

Materials, in the sense in which the word is used here, may be defined as anything which may be brought into the classroom to aid in the learning process. In the first instance it is the textbook and for the foreseeable future the printed text is likely to remain the prime learning aid. But it is by no means the only learning aid. In most science courses, the laboratory is central to the learning process, and learning aids must necessarily include laboratory equipment, laboratory manuals and guides, and the carefully designed experiment. In almost all subjects the learning process can be stimulated by motion picture films, projected directly or by means of television. Live television may also be expected to play an ever-increasing part. Programmed self-instruction may in time contribute substantially. Tape recorders are particularly significant in language teaching. Nor should the importance of secondary materials, such as posters, slides, charts, and corridor displays be ignored.

Two other learning aids might be singled out for attention here. The first of these is collateral reading matter. The provision of such reading matter becomes almost an inescapable obligation of the major curriculum revision, arising both out of its mode of operation and its purposes. The process of elimination which takes place in organizing the course implies that gaps will be left. For some students, these gaps may represent the very areas of the subject in which personal enthusiasms have been engendered, and it is only reasonable that the student be enabled to fill such gaps by his own efforts and on his own time. Collateral reading, prepared for the purpose, can help in this task.

Another major learning aid is the examination. It is not always thought of as a learning aid, but it is in fact one of the most effective. Programmed self-instruction, in at least some of its forms, is a recent recognition that the process of a monitored self-examination is a powerful learning tool.

The production of any of these materials requires the services of technicians: the writer, editor, typesetter, and publisher; the producer, director, cameraman, and film editor; the designer and manufacturer of laboratory equipment. It is in the linkage between scholar and technician that the curriculum revision is most likely to fail.

The central fact is that responsibility for the finished material can neither be assigned to the technician nor shared with him. It must lie with the scholar, and he must insist that it lie with him at all times. The writer, editor, typesetter, and publisher must serve him, and not he them. If he is making a film, he must be prepared to act to some degree as his own producer, his own director, his own cameraman, and his own film editor. This is a commitment he must make as part of any commitment to labor in the field of curriculum revision.

It is clear why this must be so. There will always be a tension between subject matter and the form of its embodiment. The best textbook, from the viewpoint of the teacher, is not necessarily the best textbook from the point of view of the professional typographer or the professional bookbinder. The criteria of teaching or of scholarship are not the criteria of film-making. These tensions must be resolved, and it is the responsibility of the scholar and the teacher to see that they are in every instance resolved in favor of scholarship and pedagogy.

This is by no means easy to accomplish. To make good films, for example, requires the services of a good director. A good director will have ideas of his own, and they will be ideas that respond to the imperatives of his own profession. But these are not the imperatives of scholarship or of pedagogy, and it will frequently happen that the scene he adamantly intends to provide is precisely the scene that distorts the subject-matter. Unless it is possible for the scholar to insist that the film satisfy his own demands at all times, rather than those of the director, the film should not be made.

The immediate and unrelenting assumption of responsibility by the scholar and teacher must accompany the production of every item of material if that material is to be worth having in the classroom. It will be a matter of constant concern, and it will demand constant vigilance.

In the production of material, as in every other phase of the program, success and failure will only be established in the classroom. Materials must be tested in use, revised, tested once again, and continue in this fashion until there is good reason to believe that they are achieving what they were designed to achieve. Every major curriculum revision has its chamber of horrors that houses the inspirations that failed when they were exposed to the student. On such occasions, there is nothing to do but try again.

The Preparation of Teachers

The student who is exposed to a new curriculum will have little trouble with it. If a course is presented to him as biology, he will accept it as representing biology as unquestioningly as he would have accepted the course it replaced.

His teacher is in a considerably different position. The teacher, if he has been any length of time in the school system, is already familiar with a biology course; he has taught it for years, he is familiar with it, and to him it is likely to represent biology. To be faced with a new course which may be entirely different in spirit and in content, and which nonetheless bears the same name and occupies the same position in the school, is somewhat disconcerting. It is also probable that the teacher will not understand it, and will not be able to teach it. Yet, as a practical matter, the new course must be taught initially and for many years by exactly such teachers.

Thus, the retraining of teachers becomes an inescapable part of the major curriculum revision. It must be built into the program from the very outset, and must be continued long after the major portion of the preparation of material is completed.

The first stage of this retraining is accomplished more or less automatically out of the necessity to associate practicing teachers with the program from the very outset. If the curriculum revision is to be realistic, it must have at all its stages the advice and guidance of teachers who are familiar with the exigencies of the classroom. Working upon the day-to-day affairs of the curriculum revision, and intimately familiar with the new materials as they develop, such teachers become retrained to a high degree of skill and comprehension.

Admittedly, their numbers are small—at best a small fraction of 1 percent of the teaching force which must ultimately be reached. Their value to the program, however, cannot be estimated by their numbers, for this small corps of highly trained, highly skilled teachers becomes the nucleus around which a major teacher-training program can be erected. In the United States, teacher training has customarily been carried on by the device of the six or eight week summer institute, in which teachers are given an intensive course in the use of new materials and the rationale of the new course. The small cadre of trained teachers who emerge from the program itself are invaluable in helping direct the first of these summer institutes and beginning the process of rapid proliferation of trained teachers.

As part of the general teacher-retraining program, the curriculum revision should accompany all its material with a copious and encompassing teacher's guide. In the Physical Science Study Committee, this guide, detailed as it could be made, was treated from the outset as a major item, and handled as carefully as any other product. In size, the finished teachers' guide was far larger than the text. From it the teacher could extract all pertinent information concerning the learning material, from an account of the philosophy which animates the course to the day-to-day detail of classroom procedures. It has become the teacher's *vade mecum.*

The problem of the initial training of teachers, in the United States at least, is a most difficult one. Institutions of higher education from which the great majority of teachers emerge, are for the most part, intensely conservative and have been resistant to curriculum change. As yet, no major program has been devised that would adopt the same approach toward curriculum in teacher-training institutions as the approach to the problem in the lower schools that is being described in this paper. In the absence of a direct attack upon this problem, however, much is likely to be achieved by the mere existence of new materials, which will ultimately force themselves upon the attention of the teacher-training institutions.

In the sections above, allusion has been made to the importance of the feedback process to the curriculum revision program. This process is an inescapable part of the development of a suitable curriculum. Until materials have been tested in actual classroom conditions, and examined scrupulously in the light of those tests, there can be no assurance that the revision is achieving any one of its important goals. The entire program must be looked upon as an experiment, and until solutions to any given program have withstood the test of use, they must be looked upon as hypotheses. In the end, it will be students and teachers who must decide upon the soundness of those hypotheses.

The establishment of a feedback loop presupposes a certain flexibility on the part of the formal school system. Classrooms and teachers must be made available within the system. At times, the structure of an examination system must be loosened to assure that students who take part in the experiment will not be penalized in their academic progress. Since the introduction of a new course is a most arduous task for the teacher, the school system must cooperate by relieving the teacher of some proportion of his normal duties in order to provide extra time for this new one.

In this regard, the United States benefits from the benign anarchy of its educational system. With some 36,000 school districts, and an almost complete absence of any central direction, it becomes possible in the United States to carry on almost any kind of educational experiment—somewhere there is certain to be a school supervisor or principal who will undertake to assist. In countries with a more rigid educational structure, reform can be effectively blocked by refusal of conservative educational administrators to cooperate in the initial steps of curriculum revision.

We have dealt so far primarily with the mechanisms of curriculum revision. These mechanisms, like all mechanisms, are significant only in terms of the persons who are associated with them. The quality of a curriculum revision is a reflection of the quality of those who carry it out; the mechanisms in themselves produce nothing of value.

It must be recognized from the outset that the task of curriculum revision is one of the most difficult of all the tasks upon which the scholar or the research scientist can embark. Before he can hope to make a matter clear to the student, he must make it clear to himself, and where the subject-matter goes back to fundamentals, this can be enormously difficult. It is only when the scholar begins to prepare material for the ten or twelve year old that he begins to realize how much he is accustomed to take for granted within his own discipline, and how little of his basic material he has ever subjected to scholarly scrutiny.

Simply because it is difficult, it requires not only scholarship and skill, but the highest degree of scholarship and skill. Successful curriculum revisions have been those in which the most eminent men and women have been willing to suspend their own careers over a long period of time to apply themselves to problems of curriculum revision. Unsuccessful revisions have been those in which this association has been denied or has been limited.

The involvement of able men and women must be direct, and it must continue through the life of the program. Those qualifications which enable a scholar to make sound decisions on the selection of subject matter are exactly the qualifications required of the man who is to write the text, evaluate the feedback, make the necessary revisions, and, in general, see the program through to completion. If these obligations are to be delegated, they must be delegated to peers.

It must be apparent that curriculum revision is a time-consuming process. The history of the Physical Science Study Committee may be instructive in this regard.

The program began to take shape early in 1956, and by September of that year it had been established that there was a willingness among first-rate physicists to undertake the work that would be required. A formal organization began to take shape during the fall of 1956, and in December of that year fifty physicists and teachers, of national stature, gathered to lay the foundation of the revision. At that meeting, a tentative selection and ordering of materials was established.

Between December and June of the following year, drafts of textual materials were made by groups who had attended the initial meeting. In the summer of 1957, an eight-week workshop completed a draft of one-fourth of the text, began the preparation of the remainder, produced one experimental film and portions of another, designed laboratory experiments and the requisite equipment, began work on the teachers' guide and examinations, and engaged in activities looking forward to the creation of other materials.

In the fall of 1957, materials already produced went into eight secondary schools for classroom testing, and an organization was created within the Physical Science Study Committee to establish and run a feedback system. In the spring of 1958, a motion picture studio was put into operation. During the summer, another eight-week workshop was held. At the same time, five summer institutes trained some three hundred teachers in the use of materials.

While production and revision continued, two hundred and fifty schools experimented with the new materials in 1958–1959. All classrooms, teachers, and students were carefully followed by the feedback process. The work of producing new materials and revising in accordance with feedback continued. Further, summer institutes were held during the summer of 1959, and during the academic years 1959–1960 the materials were used experimentally in five hundred schools. Final editing took place during the summer of 1960, and in the fall of 1960 the course entered ordinary commercial channels.

At that time the course was by no means complete: many films remained to be made and portions of the laboratory were still considered inadequate. However, the fall of 1960 can be established as the date at which the revision ceased to be experimental and became an established course. The period of preparation of materials and experimentation can thus be set at something over four years, during which some eight hundred schools and perhaps one thousand teachers were directly involved. It is worth remarking that the one thousand teachers constitute some 8 percent of the total pool of secondary school physics teachers in the United States.

It must not be concluded that the effort terminated in 1960. In addition to the materials which remained to be completed, the feedback process continued in operation, and is likely to continue into the foreseeable future. The date is already approaching when the text and associated materials should be revised, and for that purpose the feedback loop is essential. It is probable that any thoroughgoing revision of a portion of the course that may seem advisable will impose the necessity for renewed experimentation in the classrooms. In 1962–1963 operations directly connected with the use of the Physical Science Study Committee materials in secondary schools continue to run at approximately 20 percent of the peak that was reached in 1958–1959.

To some extent, this can be taken as a typical procedure for a major revision. To the degree that the Physical Science Study Committee was able to run at a full head of steam over its entire period of experimentation, the time-scale may have been shorter than that which will be experienced by other programs. In addition, it can safely be predicted that other disciplines, and particularly those within the social studies and the humanities, will prove far more difficult to handle and will require even more extensive experimentation than physics or the other natural sciences.

Finally, some remarks should be made about cost. The Physical Science Committee and most succeeding programs have adopted the principle that they must make serious demands upon the time of men and women whose time is extremely valuable both to themselves and to society, and that payment should be made for services rendered. Academic work is traditionally badly paid, and those who have engaged in curriculum revision are still badly paid in comparison to sums they might have earned in industry with a far smaller expenditure of effort. There has been, however, an attempt to elevate the rate of payment, and there has been a stubborn refusal to enlist assistance free or at bargain rates on the plea that it is "good for the country."

The cost of the revision during the period 1956–1961 was approximately six million dollars, exclusive of teacher-retraining costs, which came approximately to an equal sum. Further experience with a wide range of curriculum programs will establish a sounder base upon which to make predictions, but it is certainly reasonable to expect that in the United States costs are likely to run in the neighborhood of $1 million per annum over a period of five years for any major program, and that a revision which relies heavily on the preparation of motion pictures will find it necessary to spend at least half as much again.

Continuing costs of the Physical Science Study Committee are now running at a level of $300,000 per annum, and are likely to continue at this level indefinitely if the course is to be maintained at its present level of quality. Approximately one-third of this sum is devoted to activities which are intimately connected to the course but not central to it: preparation of special materials for advanced placement courses in physics, cooperative activities with foreign countries, and so forth. Here again, this may be taken, for the moment at least, to represent a fair approximation of what other revision programs may expect.

These costs should be measured against the total cost of the educational system, which in the United States runs at a level of $24 billion per annum. Total revision of the curriculum, on the Physical Science Study Committee scale, carried on over a period of years, could be carried at an annual cost of a small fraction of 1 percent of the educational budget.

6

CHEM Study—An Approach to Chemistry Based on Experiments

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The Chemical Education Material Study, in the years between 1960 and 1963, produced a course in chemistry. There now exist a text, a laboratory manual, a Teacher's Guide, a set of motion pictures, some wall charts and supplementary equipment, and a set of tests. These are closely integrated with one another and represent the cooperative efforts of more than 500 chemistry teachers, professors, and researchers. Nor should the role of the 60,000 students who took the course during the first three years be neglected. Theirs was a most important contribution to the finished product.

Yet the CHEM Study did not intend originally, nor has it succeeded now, to produce the definitive course in chemistry. There are many ways to teach chemistry, and, even within those schools using the CHEM Study materials, there are surely as many different approaches to the course as there are teachers teaching. What, then, did it try to do and what apparently has it accomplished?

First let us define the attempt. One of the earliest goals was to elicit from a group of experienced and talented chemists an outline of a first course in chemistry which would present an honest and encompassable view of the subject for either the terminal student or for the student who is going on for further study in science or, indeed, in chemistry. Many outlines, sequences, and emphases were suggested from which it was obvious a selection had to be made. But there was general agreement on at least two points. A first course in chemistry should be based on an excellent set of laboratory experiments. And a first course in chemistry should emphasize the importance and limitations of concepts in correlating chemical facts and in comprehending with minimum effort the wide scope of the subject.

The accomplishment of these aims clearly required more than the preparation of a text and a separate laboratory manual, so that it was early decided closely to integrate these two features of the course. It is not surprising that this decision has resulted in a set of laboratory experiments which are normally performed prior to the student's studying each particular subject in the text and that the experiments are then referred to in the text and the experimental results discussed therein. It proved impossible, however, to invent experiments which would cover all of the important fields of chemistry but which a student could do in a typical high school laboratory. As a result, a series of motion pictures were developed to give students direct experimental evidence for and conceptual insight into areas not normally accessible to the classroom teacher or to the student in his high school laboratory.

The many innovations resulting from the laboratory and conceptual emphases place a great deal of pressure on the teacher's time for the first year or two that he gives the course, plus introducing ideas not normally treated in the first course in chemistry. As a result, considerable effort was spent in producing a Teacher's Guide intended to provide on short notice ready answers to most of the problems which would arise as a teacher went through the course for the first few times. A series of tests was also produced to allow a teacher to compare the performance of his students with those of other schools and to provide examples of the kinds of questions which a student might be expected to handle. All of these aspects of the course are closely integrated and cannot actually be dealt with separately, but let us concentrate upon them one at a time in spite of that fact.

Laboratory experiments are so basic to an understanding of science that the Study decided to forego the week or two of typical introduction to chemistry and place the student immediately in the laboratory. As a result, over half the time during the first two weeks of school is spent performing experiments. A whole series of experiments based on the candle gives each student a personal introduction to many of the main conceptual ideas of chemistry in terms of a system which is safe, easy to study, and capable of direct comprehension by a beginning student.

The candle series starts by requesting the student to make as great a number of observations as he can on a candle. He is then directed to go home after the first day of school and make such further observations as he cares to. Then the second day he brings his list of observations and compares them with a list made by a professional chemist. Students are pleased when they have made observations not on the longer list, but they are impressed by the fact that their dozen or so observations could have been extended, had they been good observers, to a much longer list such as the more than fifty made by a professional chemist. They are also impressed with the possibility of making quantitative measurements and the necessity of differentiating between observations and interpretations. The series of candle experiments proceeds through a study of the thermal behaviors of pure solids when melted. The heat of combustion and heat of melting of candlewax are then compared in a quantitative fashion and the chemical reactions which go on during the combustion process are studied.

Class discussion of the candle experiments not only emphasizes the importance of careful observation and interpretation, but touches on the importance of energy effects, the question of rates of reaction, and the nature of chemical reactions, thus introducing, on a direct experimental basis, some of the relationships between the solid, liquid, and gaseous states, and between the reactants and products of a chemical reaction.

The next six laboratory experiments are mainly quantitative and lead to a full investigation of the mole concept, of Avogadro's principle, of the behavior of gases, and of simple solutions. This is followed by a third set of experiments—thirteen in number—which investigate chemical reactions starting with a study of the criteria by which one knows a reaction has occurred, going through an investigation of the energetics of reactions, chemical equilibria, quantitative titrations, oxidation-reduction, electrochemical cells, and ionic reactions. The fourth section of the laboratory experiments is based on atomic structure and the nature of chemical bonds, and is followed by a fifth section in which the chemical principles discovered and discussed in the first parts of the course are applied to various areas of descriptive chemistry. There are fifteen experiments in this last section which range from the preparation of organic and inorganic compounds to a systematic study of the chemistry of an element and its compounds, through qualitative analysis (where the student is encouraged to develop a brief scheme of his own) including a separation process involving ion exchange resins.

The total of forty-four experiments is more than enough for an average class and allows the teacher considerable leeway in selecting those experiments which will fit a particular set of students best, or even in allowing various students in the class to perform different experiments or different variations of the same experiment. Most of the experiments are quantitative and an early discussion of the nature of experimental error allows the student to become familiar with the nature of error and to evaluate his own results in terms of the experimental error. The combination of quantitative measurements plus an understanding of simple error treatment allows the student to have real confidence and pride in his results when they do, as is most common, lie within the range of experimental errors.

Since it is typical for each student to do an experiment only once, generalizations by individual students would have a very poor basis even though experimental errors were understood. As a result, teachers are encouraged to pool the class results by having each student post his results on a single chart available to all. Examination of this chart quickly shows enough experimental evidence to serve as a valid basis for reaching generalizations concerning the experiment. Typically, two-thirds of the class will be within experimental error so that a rather firm foundation for the conceptual generalizations can be provided. Experience shows that a large amount of the error which appears to be outside of experimental error appears in the calculations rather than in the measurements themselves. Students are encouraged to search for such calculation errors once class results are posted.

The experiments are chosen to build upon one another in many ways. For example, in an early experiment a copper wire is introduced into a silver nitrate solution. Metallic silver is prepared. This metallic silver is then converted into silver chloride in a later experiment, and the formula of the silver chloride determined. In a still later experiment the silver chloride is dissolved and electrolysed reclaiming the metallic silver. Not only does this allow efficient use of materials, but it encourages the student to integrate the experiments and to see that the chemistry in one case can be directly related to the chemistry in another. Even using triple-beam balances, rather than analytical balances, students are able to obtain results in such sequential experiments which show that the number of moles of silver is constant.

The experiments are sequential in a further way as well, in that the directions become less explicit as the course goes on. For example, no data tables are provided the student after the first few experiments and the directions, except as they are required for safety and relatively efficient use of time, become less and less detailed so that the student is put more and more on his own initiative.

One of the roles of the laboratory is, therefore, to put the student into a situation where he is asking questions to which he does not know the answers but is given equipment and directions which allow him in the short time available to collect sufficient data that he can, in many cases, discover the answers for himself. When these discoveries are supplemented by class discussion, the role of the experiment in scientific progress becomes a real contribution to the chemistry class.

Just as the laboratory provides situations in which the student can make his own discoveries, so the text provides a guide for the interpretation of these discoveries, for generalization upon them, and for going beyond what it is possible to do in a first-year chemistry laboratory. An important principle in the design of the course was to introduce ideas only as they were needed and as they could be used and, insofar as possible, only after they could be supported by some experimental evidence obtained by the student himself. It is assumed, for example, that almost every student entering the course believes in the existence of atoms and molecules. The CHEM Study course, therefore, deals with atoms and molecules from the beginning, but even at that stage discusses some of the experimental evidence for their existence. It also interprets the early experiments in terms of the behavior of atoms and molecules.

Yet the fuller treatment of experiments which provide the main body of proof of the existence of atoms and molecules is postponed until past the midway point in the course, since so many of these latter experiments are not directly accessible to the student but rather involve ideas and techniques which require considerable background for their comprehension. For example, the behavior of gases is interpreted early in the course in terms of atomic and molecular collisions, but the use of x-ray diffraction and other forms of spectroscopy in revealing atomic and molecular structure is postponed. Similarly, the early discussions of such topics as structure are based upon experiments which the student can indeed perform himself. Once he is familiar with the experimental method and its limitations, fewer problems arise in introducing the student to the more advanced and remote experiments which he cannot perform himself. Likewise the importance of electrical forces in chemical bonding and the tendency of atoms to acquire "the inert gas number of electrons" is presented early, whereas the more detailed interpretation in terms of ionization energy and atomic orbitals comes much later in the course.

The general organization of the text is, then, into three portions—an introductory portion where, building upon the laboratory experiments, the student discovers the basic ideas which will be used throughout the course. These include the ideas of atomic-molecular theory, chemical reactions, the gas phase and kinetic theory, condensed phases, and atomic structure and the periodic table. The second section of the text then intensively discusses these major ideas under the general headings of energy, rates, equilibrium (with examples from chemical reactions, solubility, acids and bases, oxidation-reduction), chemical calculations, atomic theory and structure, molecular structure and bonding. The third section of the book consists of a set of seven chapters which deal intensively with the principles discussed in the first portions of the course, using many applications to the chemistry of typical elements and their compounds. It is intended that all students finish the first two sections of the course and the first chapter in this last section, plus two or three of the remaining chapters at the option of the teacher. We recognize that with the time pressure existing in many high schools it is impossible for a class thoroughly to discuss all the material in the CHEM Study book. It is also true that teachers and localities vary in the type of material they wish to emphasize. Thus the CHEM

Study materials are deliberately written so that the teacher may exercise considerable option during the last month or so of the course as to the material which he feels would be of greatest use in his own classroom.

The double emphasis in both the laboratory and class on accumulation of experimental evidence followed by generalization in terms of concepts which describe a great many systems appears to have been both attractive and understandable to a great majority of the teachers and students who have had experience with the CHEM Study course to date.

A chemist is a person who makes experimental observations and then interprets them in terms of atoms and molecules and their behavior. The CHEM Study course is planned to allow even first-year students to utilize the same approach and conceptual treatment.

However, in some areas it is impossible for a first-year student successfully to experiment because of cost, safety, time, or size limitations. And there are many concepts which are difficult to describe on the printed page or with typical classroom facilities. These are the areas for which the CHEM Study films are designed. The films are typically twenty minutes long so that they may be shown easily in a classroom period and then discussed and perhaps even shown again. They are for the most part in color since color is such an important part of chemical observation. A few are based solely on the exposition of concepts using animation techniques, some involve the presentation of experimental evidence combined with animation of the interpretation, and some show an outstanding chemist at work in his research lab. All are intended to do things which the classroom teacher would like to do but which he finds impossible with his normal equipment.

In the film on *Chemical Families*, for example, samples of some seventy elements are shown. A study of the luster, electrical conductivity, and ductility of these elements followed by examination of their chemical reactions, leads to the discovery of the inert gas family followed by the discovery of the halogen and then the alkali metal family. Chemical reactions, as for example between the alkali metals and chlorine, are shown in extreme close-up so that the student can see in great detail the nature of the reaction between the metallic surface and the gaseous chlorine. The chemical similarities and differences observed then lead to the concept of chemical families which in turn is the basis of the periodic table. In the same way the film *Gases and How They Combine* provides a firm experimental basis for Avogadro's Law through a study of combining volumes. Similarly, the film on *Ionization Energy* shows how this quantity is determined experimentally for sodium and for the inert gases and then correlates ionization energy with chemical behavior.

The CHEM Study has produced a course in the sense of a text, laboratory manual and films, but it cannot produce teachers. The Study has, however, worked with hundreds of teachers to make their indispensable role as effective as possible. An important result of all this is a Teacher's Guide which has been received with considerable enthusiasm by those using the course. Let me quote from its Preface:

> The theme of the guide is support: The support is of a practical, detailed nature for day to day use plus background support to help in preparation and in giving a deeper understanding to your talented pupils. In addressing such a varied audience with its dual purpose, an important first decision is the level and intensity of approach. We adopted the plan of defining our audience as a lone teacher (isolated from other chemistry teachers) with somewhat less than ideal training, teaching in a poorly equipped school. We realize the majority of readers will not have all these problems but it is relatively easy for them to skip what is not needed. It is quite difficult for the teacher in the situation described to supply something we omit.

For each chapter of the text, the Teacher's Guide provides sections on (a) intent and approach, (b) outline, (c) new concepts, (d) schedule and related material, (e) development, (f) supplementary material, (g) background discussion and (h) answers to exercises and problems. For example, under section (h), each problem, no matter how simple, is worked out completely rather than merely having a numerical answer provided. The material of item (g) provides essentially an advanced text for the teacher, providing background material which would not normally be covered in class, but which allows the teacher to feel comfortable with the material presented at the student's level in the text. Each section (e) presents a thorough discussion of a portion of the text raising questions and discussing how they may be handled, giving additional examples and suggesting emphases and what to skip if time is pressing. Each laboratory experiment has a full discussion in this section. The evidence is strong that a teacher with a reasonable chemical background can give a most satisfactory version of the CHEM Study course using the Teacher's Guide as his main source of support. It should be emphasized, however, that attendance at a summer institute is highly desirable since, among other things, it allows the teacher to become completely familiar with the full course, to perform the experiments, and to plan his program for a whole year with knowledge of what the sequence and relative emphases are.

CHEM Study has also designed, and aided in the production of, certain equipment, wall charts, programmed materials on the use of the slide rule and exponential notation, and a complete set of examinations to cover the whole course. These were rigorously tested during the experimental program, and are now available commercially to schools wishing to use them.

Considerable effort was spent in exploring ways of carrying out a large-scale testing program such as was required during the experimental period. No other way than the use of objective questions with multiple choice answers was found. But certain variations from standard practice did seem to give results more consonant with the general emphasis of CHEM Study. For one thing, all of the examinations are of the open book type. The student is not only encouraged to use his textbook as a reference source; in certain questions he is required to refer to it in order to seek data or information necessary for the solution of the problem. This technique, plus the general emphasis of the course, seems to have discouraged pure rote memory, while not keeping the students from acquiring and filing in their memory a great deal of chemical information. In many questions, there are a sequence of items all related to one single set of experiments. This allows the student to spend a considerable amount of time considering the ramifications of one set of ideas, rather than "grasshoppering" from one unrelated item to another as is somewhat more common on objective examinations. Perhaps, in this way, some of the advantages of the essay-type test have been infused into the multiple choice possibilities. Tests typically consist of twenty-five or thirty items to be covered in 40 to 50 minutes. The national average is normally from 55 to 60 percent, the figure at which CHEM Study was aiming when the tests were written.

Reaction to CHEM Study materials has followed a fairly consistent pattern since the first trials. Initially, almost all teachers anticipate that the material is much too difficult for high school students. This is followed by a desire on the part of the teacher to try the material either with a typical group of students or with a group of better students. The third reaction is perhaps the one potentially interested teachers would be most impressed by. *It is that the teachers must work harder the first year they teach CHEM Study materials than they have ever worked in their professional careers.* Setting up the new laboratories, becoming comfortable with the new approach to chemistry, basing discussions on laboratory experiments performed by the students rather than words read in the book or delivered in class, and allowing for the freedom of approach and exploration of ideas encouraged by CHEM Study, is a time-consuming task. This time demand begins to taper off during the second year, and by the third year seems to have achieved a level which is more comparable with what is usually experienced in the way of amount of work in the more traditional approaches to chemistry.

The final reaction of the teacher, after having taught the course for a year or more, has of course been of great interest to CHEM Study. Thus far, less than 1 percent of the teachers have dropped their use of the material. The general reaction appears to be that the material is indeed demanding of the student, but not overdemanding; that some students do have difficulty with the course, but perhaps no more difficulty than they would have had with a different approach; that a larger than normal number of students become interested in the laboratory program; and that a surprising number of supposedly less able students seem to do well in the course. There is evidence, indeed, of a relatively poor correlation between commonly used measures of ability and performance in the CHEM Study course. The existence of this phenomenon cannot be definitely stated as yet, nor can real reasons for its existence, if true, be proven. But comparisons between standard aptitude measurements and performance in the course do seem to show a rather low correlation coefficient as has been discussed in the CHEM Study newsletters.

It may be that some of the enthusiasm for these new materials is based on the Hawthorne experimental effect. If this is true, I can only encourage all educational experimenters to take advantage of the effect, because it certainly seems to produce worthwhile results in the schools. But this effect can hardly account for all reactions. The teachers seem to find the approach fresh, but related to their past experience; demanding of student and teacher, but not impossible; not condescending to the student, but written in language directed at him; not concerned with definitions and experiments which the student cannot see, but based on direct observation of chemical experiments in the laboratory.

Most of the teachers who have undertaken the course so far, are probably among the abler group in the United States. However, they vary enormously in background. A few have Doctor's degrees in chemistry, some have Master's degrees, and more have gone to a special institute for six to eight weeks spent studying CHEM Study materials.

However, over half the teachers using the materials have not been to such a special institute, and do not have advanced degrees. They have, rather, undertaken to teach the course using the Teacher's Guide as their main source of information concerning it. It was with some trepidation that the Study took such a large experimental approach toward the type of backgrounds required to handle the course. Information received so far, however, indicates that very few of the teachers who are teaching the course without a summer institute, feel that they made a mistake in undertaking this effort. Almost all of them feel that it would have been desirable to have had an institute to allow them to spend the summer looking over the full course, making plans, and becoming thoroughly acquainted with it. However, the great majority of them plan to continue the course, and feel that their first year on their own was a rewarding experience. They are almost unanimous in their praise for the Teacher's Guide, and the feasibility of teaching the course with it as a background, assuming the teacher has a certain degree of competence in chemistry before he starts. Unfortunately, this article is being written only half way through the third experimental year, so the final results of this study are not available, but at mid-year the prognosis was favorable.

It was not originally, and is not now, the plan of CHEM Study to produce the definitive course in chemistry, nor to espouse its materials as the perfect way to present the subject. It is, rather, our hope that by trying new approaches which could not be attempted under other conditions, we have shown that real laboratory experimentation has a place at the high school level, that the use of concepts based on these experiments allows a more mature comprehension of the subject, and that a program which builds and grows upon itself has many advantages over a highly flexible arrangement in which the order of treatment of the subject is immaterial.

It is our hope that other authors will be encouraged to undertake the writing and preparation of courses based on the same general ideas, that their materials too may be widely tested in the schools, and that the progress of American education may be further enriched by a continual use of varied approaches.

These new curricular materials have probably been given a more severe test than any produced before. They have probably received more careful thought, by more competent teachers and chemists, than any material before. They have been revised on the basis of more student and teacher criticism than has probably ever been achieved before. What merits they have are based on the contributions of tens of thousands of individuals. It is the hope of the CHEM Study staff, now based at the Lawrence Hall of Science, University of California, Berkeley, that an ever increasing number of students and teachers will continue to find these an exciting introduction to chemistry, and a firm basis, either for further study of science, or for an understanding of the fundamental roles of scientists and scientific methods in an expanding society.

7

Renascent Biology: A Report on the AIBS Biological Sciences Curriculum Study

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The American Institute of Biological Sciences is an association of forty-seven professional societies with an aggregate membership of eighty-four thousand. During my term of office as president of the American Institute of Biological Sciences, a committee to study educational problems was established. The members of this Education Committee, chaired by Oswald Tippo, had long been concerned about the insufficient supply of new biologists and the resistance or inertia preventing the introduction of sound modern biology courses in college and high-school curriculums. In 1959, noting the excellent steps taken by the Physical Sciences Study Committee and the School Mathematics Study Group to meet similar deficiencies in science and mathematics teaching in American schools, the committee resolved to set up a curriculum study in biology. Although recognizing the great inadequacies of college courses in the subject, the members of the committee felt that effort should first be directed to the improvement of biology teaching in the secondary schools. For it is in the high schools that most students make their first acquaintance with science and its methods of exploring nature and discerning truth. At this level most students make a choice of occupation; far more future citizens are enrolled in high-school biology courses than ever attend college. Finally, much of the difficulty expe-

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rienced at the more advanced levels in interesting students in biology derives from the failure of high-school biology-teaching to awaken interest commensurate with the importance of this subject or from the quenching of that interest and curiosity in the nature of living things which is nearly universal at younger ages. I was asked to serve as chairman of a Biological Sciences Curriculum Study, to be established in the light of these needs.

Having secured substantial financial support from the National Science Foundation, the Biological Sciences Curriculum Study has moved forward rapidly since its initiation early in 1959. Under its director, Arnold B. Grobman, a professional staff was assembled at the headquarters of the study, on the campus of the University of Colorado in Boulder. A Steering Committee of some thirty persons was formed so as to include not only college and university biologists known widely for their researches as well as their interest in educational problems, but also high-school teachers of biology, writers of textbooks and teachers' handbooks, and high-school administrators. This Steering Committee met several times during 1959 and early 1960, and formulated a general plan of procedure. The members discussed various ways of attacking the problem posed by the antiquated biology curriculum in the secondary schools and considered what means might be used to thread the great biological themes and concepts through the entire fabric of whatever materials might be prepared for students to use.

There was general agreement on several major issues:

(*a*) The biological sciences are now advancing so rapidly that with every ten to fifteen years there is a doubling of our significant knowledge. This fact makes imperative a frequent reappraisal and wholesale revision of existing curriculums. It also makes it increasingly difficult to cover in any satisfactory way all that is significant and all that a general citizen should know about these sciences. The biology actually being taught in the schools today is twenty years behind the advancing front of science, and in important respects is a full century in arrears. We were unanimous in our resolve that no opposition on the part of well-meaning but uninformed persons and groups would prevent an appropriate scientific treatment of such supposedly controversial biological subjects as organic evolution, the nature of individual and racial differences, sex and reproduction in the human species, and the problems of population growth and control.

(*b*) Even worse than the failure to teach up-to-date biology is the prevalent sin of teaching the life sciences (as well as all others) as essentially a body of information established as true, together with concepts and laws of nature assumed to be unchangeable, irrevocable, and prescriptive. That our knowledge in real fact consists of limited observations, that our supposed laws are but summations of experience, and that as it develops science is continually adding new observations and consequently modifying or even replacing its one-time "laws," or that change in existing conceptions of what is true must be expected, are principles honored in the breach. Science is consequently presented to students as if the knowledge of nature were static and crystallized, or was rapidly becoming so. The conception of science as a body of methods of inquiry by means of accurate and confirmable observations, quantitative and mathematical analysis, and controlled experimentation is given lip service but fails to enter into the current experience of the student of biology at the secondary-school level. So-called laboratory work, in particular, has become a travesty of genuine science, having degenerated for the most part into mnemonic exercises that stress only the names of structures and processes and textbook definitions and explanations.

(*c*) The life sciences are so diverse, both in point of view and in methodology, that there is no single best way to organize a high-school course in biology. In point of view, there is a vast distinction between the analytical, physico-chemical approach of a biochemist or biophysicist and the organismal approach of the student of behavior and the supra-organismal view of the ecologist who deals with communities and ecosystems. Even within a single field, such as genetics, there is an extraordinary difference between the point of view of the geneticist who undertakes to explore the chemical basis of heredity and the geneticist who is concerned with the effects of evolutionary processes on the genetic composition of populations. In consequence, it is valid and necessary to explore a variety of approaches and types of organization of the subject matter to be taught.

(*d*) Whatever approach and whatever type of organization is used, the essential character of scientific activity and the great biological themes must permeate the treatment. This principle means that, on the one hand, the nature of science as an increasingly important aspect of human history—including the development of science through the correction of past errors, discovery of new evidence, and synthesis of new concepts—is to be stressed. The principle means, on the other hand, that the biological themes of the interdependence of structure and function, regulation and homeostasis, the genetic continuity of life, its evolution, the diversity of type together with unity of pattern, the biological roots of behavior, and the relation of organism to environment must be treated at all levels of organization, from the molecular level to the ecosystem, and at all stages of process, from the chemical reaction through the growth and development of the individual to the ultimate evolutionary changes with time. To do this is most difficult and has never really been attempted. But to achieve it is fundamental to a modern view of the life sciences.

(*e*) As George Sarton, our greatest historian of science, has said, "It is not at all necessary that the average man should be acquainted with the latest theory of the universe or the newest hormone, but it is very necessary that he should understand as clearly as possible the purpose and the methods of science. This is the business of our schools, not simply of the colleges but of all the schools from the kindergarten up."

A rapidly changing society whose ways of life are continually disrupted and transformed by the advances of science and scientific technologies, and a democracy in which ultimate policy depends upon the enlightenment of the average citizen, must provide for the general citizen an education that makes possible adjustment to changing conditions, as well as some degree of foresight—an education that provides an understanding of the very nature of the scientific process that makes inevitable the gravest decisions. Is science friend or foe of mankind? We were agreed that the boy or girl in school cannot comprehend the nature of science by learning facts about nature. Instead, real participation in scientific inquiry, and as full a participation as possible, should be provided. Only by engaging in the steps of scientific inquiry may a student become able to discern the true difference between sound experiment that provides evidence and complex instrumentation that offers a show —between evidence and authority, between science and magic. This conclusion called for a thorough and radical change in the character and emphasis of most current science teaching.

(*f*) A sound biological understanding is the inalienable right of every child who, when adult, will need to cope with individual problems of health and nutrition; with family problems of sex and reproduction and parenthood; and with the citizen's problems of wise management of national resources, the biological hazards of nuclear agents in peace and in war, and governmental support of science as the primary source of national strength and well-being in the scientific era. Consequently it seemed that the placement of biology in the high-school curriculum ought to remain at a level where it will be studied by the great majority of students; that is, at the tenth-grade level as at present, rather than in a sequence following the study of physics and chemistry. Granting that modern biology cannot be taught without a considerable understanding of the physical sciences, we nevertheless felt that rather than postpone biology to the terminal year of high school, when it would very probably be elected by no more than 20 percent of all high-school students, it would be far better to undertake a thoroughgoing improvement of the science curriculum at the junior high school level. If a sound foundation in the basic concepts of physics and chemistry could be provided in those earlier years, biology could be taught in effective and modern terms at the tenth-grade level to almost all high-school students. We therefore set as an objective the preparation of course materials for all high-school students, irrespective of their future choices of occupation or their intention to go to college. This primary goal would not prevent experimentation with biology courses designed for selected groups, either at an earlier or a later period of secondary education.

The first major working committees to be established and to develop programs were a Committee for Innovation in Laboratory Instruction, under Addison E. Lee of the University of Texas, and a Committee on Course Content, under John A. Moore of Columbia University. The first of these two committees was to grapple in particular with the problem of real student participation in scientific inquiry. The second committee was to start the task of organizing subject matter and laboratory programs in the light of all the foregoing objectives. These two undertakings have proceeded in relative independence, the former developing the "Laboratory Block" program and the latter preparing several distinctive versions of subject matter and correlated laboratory exercises.

Discussion brought out the possibility that, in aiming both of these programs at the generality of high-school students, those students who are particularly able, gifted, and capable of highly original and individual work in biology might be neglected. A third working committee was therefore established, to prepare materials for the guidance and use of especially gifted children. This committee worked under the chairmanship of Paul Brandwein, whose past leadership in this field is well known.

The Committee on the Gifted Student conceived the idea of soliciting from research biologists a variety of problems, still unsolved, that might be suitable for highly gifted students to use as subjects of individual research. The response was almost overwhelming. Hundreds of research problems were received and screened. A special task force was assembled to edit these problems carefully and to prepare an initial volume of one hundred of these during the summer of 1960. This plan was carried out by a team working for several weeks at Boulder, and the result was a volume entitled *Biological Investigations for Secondary School Students*, which was issued early in 1961 (1).

To start the major task of preparing several versions of course materials embodying different approaches to the life sciences, it was decided to draft the services of a considerable number of high-school biology teachers and college and university specialists in different fields. During the summer of 1960 sixty-nine writers—together with a corps of typists, illustrators, and clerical personnel—were assembled in Boulder for seven weeks. The writers, according to their main interests, were grouped into teams to work on three versions—known as Yellow, Blue, and Green—to emphasize respectively the genetic and developmental, the biochemical and physiological, and the ecological and evolutionary approaches to biology. Each team of writers had a supervisor: John A. Moore for the Yellow Version (2), Ingrith Deyrup of Barnard College for the Blue Version

(3), and Marston Bates of the University of Michigan for the Green Version (4). Each college biologist was paired with a high-school colleague, so that the one might provide expertness on content, the other on level and manner of presentation. Half of the writers were assigned to the preparation of laboratory exercises intended to be closely co-ordinated with the respective textbook versions and to exemplify, in so far as possible, the quantitative treatment of data and the use of controlled experiment in biological work. These teams were under the writer's supervision. As experiments were prepared, each one was given a preliminary testing by twenty select high-school students working under the direction of two high-school teachers. These students also read and criticized many portions of the text of each of the three versions.

In spite of what seemed an insuperable task, of differences of opinion and of some confusion resulting from lack of foresight and co-ordination in this unprecedented venture, the three versions, together with their laboratory accompaniments and teacher's guides for laboratory work, were drafted within seven weeks. Moreover, the first of three parts, into which each version was divided, was revised and printed in time to be used during the last week of August in a briefing session held for the prospective teachers. The remaining parts were completed, printed, and distributed in November, 1960, and January, 1961, in time for use by classes selected for the preliminary trials during 1960–1961. The complex problems of organizing, housing, and guiding this writing conference to a completion of its task in less than two months were handled with great skill by the director of the Biological Sciences Curriculum Study and his assistant director, Walter Auffenberg. The assistant director, in particular, deserves much credit for seeing the books successfully through the press and for handling a multitude of production problems expeditiously, so that deadlines for distribution and use in the classroom were met.

Meanwhile, the staff had set up a plan for testing on a national scale the new course materials, as well as the four laboratory blocks that by this time were also ready for use. Fifteen geographic centers were selected, ranging from Los Angeles to Long Island, from southern Florida to Salt Lake City and San Francisco. In each center six or seven teachers were chosen, one of whom served as chairman of the group. These teachers had all attended the briefing session in August to acquaint themselves with the new biology courses. They agreed to use a single version in a given center and to meet weekly to confer about their teaching problems and to supply the headquarters in Boulder with detailed and specific reports, containing criticisms and suggested changes. They further agreed to use in their classes the special tests and examinations that were prepared by Educational Testing Service and a committee of biologists from the summer writing conference. A college biologist was assigned to each center to serve as a consultant. Each center was given a small reference library and a modest budget for expenses, and each teacher was paid a stipend for the extra time involved in the meetings and reports. In all, one hundred and five teachers in the testing centers and thirteen in independent situations taught the courses of the Biological Sciences Curriculum Study to approximately fourteen thousand students during this first year of the period of testing.

Five centers taught the Green Version, five the Blue Version, and five the Yellow Version. The four laboratory blocks were assigned to eight centers, in such a way that each block was used by two centers using different versions of the textbooks. The staff at Boulder was enlarged to include two full-time persons who during this first year of trial had the primary assignment of keeping in touch with the work of the centers and collating and summarizing their reports. One of these members of the staff was an experienced high-school biology teacher, Norman Abraham, the other a college biologist, Alfred Novak. These men visited all the teaching centers during the year, observed the instruction in the classroom and laboratories, and reduced the voluminous feedback received weekly from the centers to a concise and manageable form. These contacts not only served to maintain high morale in the centers, in the face of many difficulties that inevitably arose during the first year of a new program, but further proved to be of inestimable value when the time came, during the summer of 1961, to use the feedback in the task of revising the textbooks and laboratory manuals.

In general, the responses of students and teachers to the three new versions of biology taught during 1960–1961 were warm and enthusiastic, and criticisms were limited to minor matters. The impression I received during visits to classes and conferences with the teachers of one center was that a new and lively spirit had been infused into the teaching of biology. The textbook material seemed to offer most difficulty, particularly for students below average in ability. Over and over we heard the comment, on the other hand, that the new laboratory program was a revelation to teachers and students alike; that enthusiasm for their experimental activities led students to continue their work at home and on weekends in unprecedented fashion; and that the teachers, though they found the new methods entailed far more work on their own part, would not dream of going back to their former way of teaching biology or any other science. In particular, the quantitative treatment of data collected by students working individually or in teams was greeted enthusiastically; and students who "goofed" in their responsibility for making a particular observation or for carrying out a particular operation were made to feel, by strong social censure from their fellows, that their behavior was intolerable. After directions for a laboratory exercise had been given, it seemed that the class itself assumed responsibility, and the teacher had more to do in reining in the overimpetuous and restraining the rather noisy, free activity than in actively guiding the work. Quite beyond expectation, it was laboratory work, and especially the laboratory block programs, that aroused the eager participation of students of below-average ability; and, in "doing science," many of them revealed scientific ability that their low verbal competence had previously concealed.

Yet a word of caution must be added. The successful conduct of the laboratory programs requires that the teacher have practical experience with the methods to be used as well as familiarity with the background of the work to an extent far exceeding what is necessary in simply teaching from a textbook. The laboratory blocks, in particular, were most successful when the teacher employing them had an adequate background in the specific field of work involved. They were not so successful when the teacher lacked the requisite experience. These observations point to the necessity for more specific training in experimental methods in the preparation of biology teachers and to the need for in-service and summer institutes that will provide this type of training for our present body of biology teachers.

In the summer of 1961 a second seven-week writing conference was held in Boulder. It was devoted to making a thorough revision of the three versions. During the year, in addition to the feedback received from the fifteen teaching centers and from the independent teachers, the Steering Committee had met twice to evaluate and criticize the textbooks and laboratory manuals. Everyone was frank to acknowledge the deficiencies of a product evolved under heavy pressure of time and through the collaboration of many persons. Apart from lapses into error, a major defect was thought to be the failure to keep the great themes of biology, especially the theme of organic evolution, sufficiently prominent throughout. Treatment of such subjects as evolution was adequate in chapters devoted specifically to them, but the themes did not, as had been hoped, form the warp and woof of the fabric. Too often the treatment lapsed into the old pattern of straightforward, didactic exposition of scientific "fact." There was but occasional emphasis upon the nature of the scientific evidence on which our present conclusions are based or upon the modification of scientific theories and "laws" in the light of ever growing evidence. Ecology was given much space, particularly in the Green Version, yet there was a general failure to consider the relations between the internal system and the external environment at all levels of organization. Regulation and homeostasis, so characteristic of this relationship, were not sufficiently emphasized.

Another prominent defect, it was felt, lay in the organization of the material. This fault arose in large part because different chapters had been written by different teams working simultaneously and without foreknowledge of the choice of subject matter or the treatment that would be given to subjects that preceded or followed their own assignment. This inevitable lack of co-ordination was frequently evident in the relation between textbooks and laboratory exercises, since the latter had to be formulated, and even prepared in final form, often before the cognate text had seen the light of day. The same sort of deficiency was noticeable in the treatment of the chemical and biochemical background of biological activities. The writers of the original versions had been highly successful in introducing extensive treatments of the chemical basis of life processes —in fact, far more extensive than what is conventionally taught in college biology courses—and they had achieved a progressive treatment that made the material assimilable by a large proportion of tenth-grade students. Nevertheless, the chemistry and biochemistry proved to occupy rather formidable masses of subject matter not always, in the student's eyes, clearly and directly related to biological matters. It was recognized that a far superior way of treating the chemical basis of life would be to introduce most of the chemical information gradually, in context with the discussion of biological activities that require the chemical background for adequate understanding.

At one meeting the Steering Committee conferred with the new writing groups before the revisions were begun. In addition to all the foregoing comments and criticisms, the Biological Sciences Curriculum Study sent out its books to a number of biologists, representing every major specialty, and also to the officers of the member societies of the American Institute of Biological Sciences, quite a few of which had education committees of their own with comments to make. The critiques prepared by individual biologists were particularly helpful.

In the revision of 1961 the Blue (5) and Yellow Versions (6) were extensively revised in organization, while the Green Version (7) seemed to require chiefly an expansion of some parts and a reduction of others in order to secure a more balanced emphasis. The Blue Version, supervised in 1961 by Claude Welch of Michigan State University, now emphasizes two major themes: the origin of life and its evolution; and the nature of scientific inquiry, which is likened to the task of a detective. At the same time the basic emphasis on the physiological and molecular approach to biological problems has not been obscured. In the Yellow Version the new approach is the cellular, and a definite effort has been made to distribute the biochemistry and to integrate it more fully with biological processes.

To insure that adequate attention would be given to the great pervading themes of biology, a special team was established under the writer's direction. Each member of this team assumed responsibility for one or two of the nine themes selected and scrutinized every new draft of any section of text in order to recommend ways and means of more effectively bringing out the pervading themes without doing violence to the organization and continuity of the treatment. Often the "thematists" found ways of introducing illustrations, cross references to other discussions, and brief passages into the text. Sometimes they found it necessary to draft a lengthier account. Although this method of focusing emphasis on the themes cannot be said to have operated as smoothly and as consistently as more deliberate ways of working up literary material might have, both the members of the thematic team and the writers of the Blue, Yellow, and Green Versions are satisfied that great advantages derived from it.

During the 1961–1962 school year the number of centers engaged in testing the Biological Sciences Curriculum Study materials in the classroom and laboratory was increased to thirty-five, covering nineteen states and ranging from Vermont to Hawaii, from Washington to Florida. About three hundred and fifty teachers in these centers will instruct over thirty thousand students in the 1961–1962 testing program. In addition, many teachers who worked with the Biological Sciences Curriculum Study materials in summer institutes will participate in the program, although not in center groups; and some large school systems, including that of Miami (Dade County), Florida, are purchasing books for many of their local classes in biology. In all, over fifty thousand students and five hundred teachers in thirty-seven states and four foreign countries will use the Biological Sciences Curriculum Study courses in 1961–1962. As in 1960–1961, reports and criticisms from the teachers in these centers will serve as an invaluable basis for what is expected to be the final revision of the textbooks and laboratory guides. This revision will start in June, 1962; and it is hoped that by the opening of the schools in 1963 books will be ready for general adoption and use, wherever teachers and school authorities may desire. Commercial publication and distribution at that time is anticipated. The wide range of selection and choice among the three versions and the other course materials, including the laboratory blocks, should be emphasized.

When Louis Agassiz and Thomas Henry Huxley introduced the teaching laboratory in biology, about a century ago, they had one primary purpose in mind. Their insight was a simple one: seeing is believing. In teaching science one must appeal not to the authority of a teacher or book; one must look squarely at the facts, at the infinitely varied phenomena of nature. The first function of the laboratory in teaching, then, is to present the evidence from nature that supports our biological concepts. This might be called the *illustrative function* of the teaching laboratory.

The illustrative function has been heavily emphasized in the past —often to the exclusion of everything else. Students have come to spend most of their time watching demonstrations, looking through the microscope, dissecting dead animals or plants, learning names, labeling drawings. Even when they were given a so-called experiment, all too often there was nothing in the least experimental about it. They have repeated, step by step, some well-worn procedure, perhaps illustrating a classic discovery of one or two, or even three, centuries ago. They have known in advance, from textbook and discussion, exactly what they were supposed to discern and conclude. It has been sheer cookbookery, a ritual of recipes. Small wonder that interest was often deadened. Little wonder that in this day of advanced audio-visual aids many educators have thought that large classes might see all that needed to be seen, and in much more effective fashion, if well-prepared motion pictures and sound were substituted for the routine of the laboratory.

But there is another function of the teaching laboratory and fieldwork, a function that cannot be replaced by audio-visual aids, demonstrations, or museums, no matter how excellent. To understand the nature of the scientific process one must participate actively in it—one must investigate some problem, the answer to which is unknown. If the paramount aim of science teaching in general education is to prepare citizens—most of whom will be non-scientists—to participate intelligently in the affairs of a scientific age, then the investigatory function of science teaching seems more important than any other. As the Foreword in each BSCS laboratory manual puts it: "No matter how much you learn about the facts of science, you will never quite understand what makes science the force it is in human history, or the scientists the sorts of people they are, until you have shared with them such an experience. The laboratory and field are the scientists' workshops. Much reading and discussion are essential in scientific work, but it is in the laboratory and field that hypotheses are tested."

Properly to do this, the experience must involve real, not make-believe, scientific investigation. One must approach the frontier of existing knowledge and deal not merely with what is unknown to the student, but with what is likewise unknown to the teacher and to the scientists who have prepared the teaching program—to everyone, in fact. Is that an impossibility, in the advanced stage of modern science? Perhaps in some sciences it is indeed. Fortunately, in the biological sciences one deals always with sufficient variables to render the outcome of a particular procedure uncertain. For example, one may know that a given concentration of thyroxin will accelerate the development of leopard frog tadpoles, but not what it will do to bullfrog tadpoles. It may simply kill them. Or one may know how a mutant called *dumpy,* in the fruitfly *Drosophila melanogaster,* is inherited—say, as a simple recessive, on chromosome 2. But a new mutant, although possessing a very similar phenotype, may turn out to be dominant and located in some different chromosome.

Even so, the investigatory experience must be provided in some depth, far exceeding what is ordinarily possible with brief exercises that are planned to accompany the study and discussion of a textbook day by day. To meet this hitherto largely neglected need, the laboratory block program has been devised. If the primary aim is to lead students to understand scientific methods of investigation and to appreciate the spirit and the outlook of a scientist, then it matters little what particular area is chosen. It is more important that the students have an opportunity to move step by step, from acquiring the necessary skills and preliminary acquaintance with the problems involved, toward the frontier of knowledge, where they can explore together a bit of the unknown and learn that by patience and carefulness, persistence to the point of obstinacy, precision in measurement, and accuracy in observation they can sometimes experience the joy of discovery. They must learn to ask the right questions, that is, to frame testable hypotheses. They must learn to draw valid conclusions from their data and to determine the significance of their findings. They must learn that science frequently advances through the correction of the errors and inadequacies of earlier science. And all of this takes time.

In past patterns of instruction, something of this sort has occasionally been provided for the gifted student by assigning him an individual project. Only too often, however, the student is left to flounder because the teacher lacks time and energy to supervise a number of individual projects over and above the heavy load of large-sized classes which are all too common in our schools. What the Biological Sciences Curriculum Study has sought, therefore, is a plan of instruction that would involve each entire class, yet provide real depth of investigation. The solution seems to have been found in the laboratory blocks. Each of these blocks deals with a circumscribed area of biological problems, within which considerable homogeneity of materials and methods may be utilized. Each block is planned to occupy a six-week period during which all other activities of the class (textbook assignments and discussions, regular laboratory exercises, etc.) are suspended. By careful planning, it is possible to have several independent experiments going on simultaneously or overlapping in time. The class is divided into squads which replicate each experiment; and each squad may be divided into teams that perform a particular part of the experiment. For example, one team may handle the control group of organisms, another team the organisms under a first set of experimental conditions, a third team those under a second set of experimental conditions. High group morale and personal responsibility develop as each student realizes that his own part is indispensable to the good results of his teams and his squad. Time is allotted in the program for assembling the results, for quantitative handling of the data, and for comparison and discussion of the results as a whole. There is insistence on keeping clear and accurate records and on reporting the total experiment in scientific fashion.

Already four of these blocks have been prepared, pretested in a single school, and thereafter tested on a larger scale, each in two geographical centers and by six or seven teachers in each center. These blocks deal respectively with Microbes: Their Growth, Nutrition, and Interaction (8); Animal Growth and Development (9); Plant Growth and Development (10); and Interdependence of Structure and Function (11). As was mentioned previously, the laboratory blocks were received by teachers and students with enthusiasm. In spite of the arduous work involved on the part of teachers in preparing materials for such a program, and in spite of the extra assignments that required students to spend time out of school to make continuous observations, students and teachers alike expressed reluctance to return to the more conventional patterns of instruction.

Typical student comments were of the following sort: "What are we learning? We're learning how scientists discover things." "This is hard but it's fun." "Our results don't come out the way we expected, and then we try to find out why."

Additional blocks have been completed in preliminary form on the topics: Ecology of Land Plants and Animals (12); Regulation in Plants by Hormones (in press); and Animal Behavior (in press). Other blocks are in preparation on the subjects of Physiological Adaptation in Animals and of Genetic Continuity. Possibly others will be prepared dealing with such subjects as radiation biology, light and life, evolution, and nutrition. The full plan is to have a sufficient number and variety of laboratory blocks, say at least a dozen, to permit every teacher to select for his classes one that is consonant with his own preparation and is adapted to the locality and the student body. It will be best to introduce each laboratory block in the year's program after the class has made some preliminary study of the biological information basic to the use of that block. If this is done, the unavoidable curtailment of the rest of the biology course, which must occur whenever a six-week laboratory block is used, will be minimized, especially since most of the regular laboratory program dealing with the same subject can then be omitted. But whether or not this saving is possible, the sacrifice of time that would otherwise be devoted to the general coverage of biology seems well worth while, if the block, no matter what its particular subject matter, can generate understandings of the nature of scientific inquiry that conventional teaching methods are quite unable to do.

Teachers may want to use different blocks in different years, or even in different classes during the same year, although the latter choice would involve excessive time and labor in preparation. Several teachers are now trying out the idea of making up an advanced biology course by using three or four laboratory blocks in sequence, with suitable connecting studies. It is also worth noting that a committee appointed by the Biological Sciences Curriculum Study to report on the feasibility of and the need for college biology curriculum studies that might be co-ordinated with the BSCS program reached the following conclusions. First, the revolution in biology at the high-school level makes it imperative to rethink and replan both the introductory college biology course and the courses for teacher training. Second, while plenty of good college textbooks exist, and at present there is no need to prepare more of them, the program of the teaching laboratory, as commonly taught, is stultified and almost deadening. Third, the best means of redirecting laboratory teaching toward the goals thought to be most important is through preparation of laboratory blocks, comparable to those being used successfully at the high-school level, but more advanced.

Finally, let it be said that the laboratory block program is somewhat more expensive than alternative ways of teaching biology. The program will generally require that the teacher carry a lighter class load and that classes be reduced toward an optimum size of about twenty-five. A laboratory assistant may also be required for each group of classes, to help prepare for the experimental work and to help in the checking of the voluminous data sheets and reports. The program will require, particularly the first time a given block is taught in a school, some outlay, both for permanent equipment and for expendable materials such as glassware and chemicals. It is a notable fact that schools which have participated in the BSCS laboratory block program thus far, while helped through loans of equipment from the Biological Sciences Curriculum Study, have also found the program a reasonable and sufficient basis for requesting, and getting, certain types of equipment from the school administration. For example, the experience is helping to make routine the provision in each classroom-laboratory of sufficient gas, electric, and water outlets, sinks, and storage space. A refrigerator is now recognized as necessary. Provision of enough binocular dissecting microscopes to equal the number of the compound microscopes conventionally provided is recommended as being among the best possible uses of funds available under Title 3 of the National Defense Education Act. The associates of the Committee on Innovation in Laboratory Instruction have devised many simple, homemade types of equipment that may satisfactorily be substituted for the far more expensive commercial instruments.

To conclude, the laboratory block program, as developed thus far, gives promise of being this generation's most exciting innovation in the methods of teaching science. Every report thus far received agrees that, whatever the expense and the added burden in time and energy, almost no teacher who has once included a laboratory block in the biology course would go back to the old way of teaching and almost every student who has participated in such a course regards the laboratory block as the high point of the year.

Very early it became apparent to the staff and to the Steering Committee of the Biological Sciences Curriculum Study that a formidable obstacle to the wide use of the new biology courses lies in the lack of adequate preparation of high-school biology teachers in many areas of modern biology. A Committee on Teacher Preparation was therefore established, under the chairmanship of Joseph J. Schwab, of the University of Chicago. While laying plans for the specific orientation and preparation of teachers using BSCS materials, this committee was early involved in several conferences called by a joint study of the American Association for the Advancement of Science and the National Association of State Directors of Teacher Education and Certification. These conferences prepared the way for a redrafting of the state *Guidelines* (13) setting forth the desirable content of teacher preparation in the natural sciences. Not only the committee members and its chairman, but the director and the chairman of the Biological Sciences Curriculum Study participated actively in the conferences and the drafting of new recommendations for the preparation of secondary-school biology teachers. For biology, these guidelines recommend that the prospective teacher should take a major, that is, at least a full year of college work, in the life sciences. The program should include either general biology or a combination of separate courses in microbiology, botany, and zoology. In addition, there should be approximately a year of work in mathematics and the other sciences, such as physics, chemistry, geology, and psychology.

During the writing conference of 1960, in addition to the *Teacher's Guides* that accompany the laboratory guides for the students, a *Teacher's Commentary* (14) was prepared, largely by Joseph Schwab. This volume attempted to provide, in three sections, "a background to biology," including a discussion of issues of principle in biology and a consideration of *part* and *whole* as principles of enquiry; notes and references for each of the three versions, Green, Yellow, and Blue; and "Invitations to Enquiry," a series of highly suggestive guides to various discussions that a teacher might have with his class in order to develop more fully the concepts of scientific investigation. The very titles of these invitations to enquiry should intrigue the curiosity: the meaning of classification; a case of conflicting evidence; cause and correlation; a pattern of experimental enquiry; on the role of assumptions in science; "creating" an animal to specifications; "blue babies"; mice, men, and traps; conflict of evidence about tree rings. Although the ideas embodied in this volume were broadly acclaimed, teachers in the centers seem to have used the book rather little—in part, no doubt, because of the burden of much new material in textbook and laboratory with which they had to familiarize themselves, and in part because the style seems to have been too philosophical for most high-school teachers. During the writing conference of 1961 a major effort was made to remedy these defects and to produce a more usable yet no less stimulating book.

The result is *The Teacher's Handbook* (15), prepared to go with all three versions, and produced by Joseph Schwab with the assistance of a team of several co-writers. The volume is now much larger than its predecessor. It contains three principal sections: the first, on the background, emphases, and aims of BSCS biology; the second, invitations to enquiry; and the third, specific explanations and aids to help in preparing to teach the BSCS materials. The invitations to enquiry are grouped into sixteen that deal with the role and nature of general knowledge, data, experiment, control, hypothesis, and problem in scientific investigation; eleven on the conception of cause (factors, multiple causes, time sequences, negative causation, feedback); six on quantitative relations in biology (linear and exponential relations, rate and change of rate, units and constants); and six on the concept of function in biology (evidences of function, doubtfulness of functional inference, argument from design versus argument from adaptation). Two more groups of these invitations to enquiry are promised for Part II of *The Teacher's Handbook*. Of these discussions it may be said without qualification that nothing comparable to them for orienting teachers and students alike has ever been produced. Teachers of college biology and research workers in the field will find them exceedingly instructive, and they might well be assigned as required reading for graduate students in the biological sciences.

During the course of the 1960–1961 school year it became evident from the practical difficulties experienced by the BSCS teachers in the classroom-laboratory that organized assistance must be given to provide students and teachers with many aids besides the books. Appropriate reference books and articles needed to be cited for each section of the work. Other needs included critical guides to available motion pictures suitable for use with certain chapters; specifications for a reasonably well-equipped high-school biology laboratory using a BSCS course; guidance to sources of biological materials and suppliers of special equipment; and designs for making cheap but adequate instruments and apparatus from readily available materials. Seeing the need, members of the 1960 writing conference prepared three short films on certain technical operations that are easily comprehended when seen, but very difficult to explain in words. These films dealt with methods of sterile microbial culture; methods of growing, etherizing, and examining fruitflies (Drosophila); and methods of extracting pituitary glands from frogs for injections to induce ovulation.

Meanwhile the project associates working in Austin, Texas, on the laboratory block program had devised many kinds of useful and readily made equipment, such as a simple housing and socket for an ultraviolet lamp, a colorimeter, a constant temperature box (for cooling), a constant temperature box (for elevated temperatures), a shaker, an electric stimulator, a muscle lever, desk-top greenhouse, and thermostat. Such apparatus can be made chiefly from spare parts of discarded household equipment and simple, inexpensive items obtainable at local hardware or dime stores.

Various activities such as these have now been concentrated under a single Learning Aids Committee, of which Paul DeHart Hurd of Stanford University is chairman and to which a member of the BSCS staff, George I. Schwartz, gives full time. More films dealing with simple laboratory operations were made during the summer of 1961 or are being planned. Much work has been done to evaluate critically the hundreds of available movie films on biological subjects and to collate the best of these with the appropriate parts of the three textbooks. Alfred Novak and Norman Abraham, on the basis of their visits to many schools, have prepared a table of specifications and a check list which biology teachers may use as a self-rating scheme to determine whether their own facilities are optimal, mediocre, or very poor. The collaboration of biological suppliers in different parts of the country has been sought, and with considerable success.

Besides the need for the forty volumes of text versions, laboratory guides, teacher's guides, laboratory blocks, and *The Teacher's Handbook* already discussed, a need for other types of publication was envisaged early in the program. A Publications Committee was formed to plan for these. One such type of publication is a series of BSCS bulletins dealing with professional aspects of biological education and teacher preparation. The first publication in this series was published in 1961 and is Paul DeHart Hurd's *Biological Education in American Secondary Schools 1890–1960* (16). At least one more book in this series is being planned.

Also in preparation is a series of pamphlets for teachers and students, each number of which is to treat a particular biological subject as extensively, currently, and simply as possible. Each article will be specially illustrated and will be provided with a reasonably full list of references to which the interested student of the subject may go for further enlightenment. These pamphlets will probably be distributed by subscription at as low a price as possible.

During the 1960–1961 school year tests and longer examinations for midyear and final periods were prepared for the Biological Sciences Curriculum Study by the Educational Testing Service, of Princeton, New Jersey. These were administered by the teachers in the centers to all their classes. Data are now being analyzed to permit a comparison of the relative showing on these examinations of students rating high, medium, and low on a standard aptitude test. During the 1961–1962 school year a much greater testing program will be undertaken. It is planned to make cross comparisons of the results from a general achievement test given at the end of the year—not only between classes using different BSCS versions, with or without six-week laboratory blocks during the year—but also with classes using non-BSCS textbooks and subject to conventional methods of teaching. An Evaluation Committee (Bentley Glass, chairman) will carry out this study; and Hulda Grobman, of the BSCS staff, is devoting much of her time to this work. Subcommittees have been formed, one to prepare appropriate examinations for the courses and for the laboratory blocks (in conjunction with Educational Testing Service), another to analyze and evaluate the results in terms of educational experience.

Quite early, expressions of interest in the plans and programs of the Biological Sciences Curriculum Study began to arrive from foreign countries. Some of these were from Great Britain and various other European countries. Others came from countries in South America, Africa, and Asia. So many inquiries came that a special committee was formed to deal with matters of international cooperation and foreign utilization, under the chairmanship of James G. Dickson, past president of the American Institute of Biological Sciences. This committee obtained special financial support from the National Science Foundation and the Rockefeller Foundation and was thus enabled to bring to Boulder, to participate in the 1961 writing conference, a total of nine biologists from abroad: two from the Argentine Republic, two from Brazil, two from Colombia, two from Thailand, and one from Nigeria. Each pair of visitors consisted of a secondary-school biology teacher and a university biologist. Under the general guidance of Archie Carr, of the University of Florida, these teams translated and adapted BSCS text and laboratory materials into their own languages, and incidentally contributed no little to the progress of the revisions going on during the summer. The enthusiasm of our friends from abroad mounted, and by the summer's end plans were afoot for a much larger cooperative biology curriculum program to be launched in Latin America; and the continuation of the programs in other parts of the world seemed assured.

Demands for information about the BSCS program have required much staff time to answer. Several brochures have been printed. Articles have been published by the director and other members of the staff or participants in the program. Addison Lee has described the laboratory block program in an article. Many addresses and panel discussions have taken place. The *BSCS Newsletter* (17), edited by Hulda Grobman of the staff, has reached its ninth issue and gives a sequential story of the development of the Biological

Sciences Curriculum Study that is most informative. In addition, she has prepared exhibits, to illustrate graphically the nature of the BSCS program, for annual meetings of the AIBS societies and other large scientific organizations. Exhibits have been sent to India and to Hawaii for display at scientific congresses.

Adorning the covers of the BSCS textbooks and manuals and seen also on the *BSCS Newsletter*, is what has unofficially and by general acclaim become the symbol of the Biological Sciences Curriculum Study. It is the impressionistic outline of a browsing stag, drawn by Jane Larson, illustration supervisor of the BSCS staff. To her and her assistants, to Margaret Grant, capable editor of the textbooks, guides, and handbooks, and to Margaret Sterling, efficient administrative assistant, as well as to the many typists, mimeographers, delivery boys and their supervisors, all of whom worked long hours cheerfully to help make the BSCS books come to realization on time, one must make special acknowledgment. Like the writers, the teachers, and the center leaders, all of whom have labored beyond the call of duty, without them the Biological Sciences Curriculum Study could not be a living, growing reality.

In sum and substance, what is the BSCS program that past efforts to improve the science curriculum of the secondary schools were not? One might say two principal things in reply. For the first time in the history of American education we now see a large number of research scientists, from the colleges and universities, taking part in a co-operative effort with high-school teachers of science and science supervisors to replace an antiquated body of scientific knowledge and outlook with subject matter and perspective that are truly current. The Physical Science Study Committee and the School Mathematics Study Group, the two curriculum studies begun earlier, moved in this direction. But I believe that only in the Biological Sciences Curriculum Study has this fruitful collaboration been fully realized. The result is as astounding to the research biologist as to the high-school teacher. How nearly fatal that until so recently no one seemed to realize that this must be the way—the only way, in an ever accelerating pace of scientific advance—to provide the well-oriented education in the sciences that modern man must have.

That is one answer to the question. The other is this. For the first time, I think, education in the natural sciences, at least at the secondary level, has assigned the acquisition of scientific information and concepts a place of lesser importance than the understanding of the very nature of scientific enquiry and of the scientific enterprise in which modern man is embarked. As I wrote on an earlier occasion: "The aim of the Biological Sciences Curriculum Study is to place biological knowledge in its fullest modern perspective. If we are successful, students of the new biology should acquire not only an intellectual and esthetic appreciation for the complexities of living things and their interrelationships in nature, but also for the ways in which new knowledge is gained and tested, old errors eliminated, and an ever closer approximation to truth attained."

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Implementation of Curriculum Change in the Sciences: A Case Study

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Over the past three or four years, the teaching of science in the public schools of Florida has changed dramatically. As a result, the attention of those concerned with science education has been focused on Florida and the programs of the schools have been examined from many quarters. Still there is wide misunderstanding as to what is going on in our schools and some disagreement, mostly by people outside the state, over whether it is wise for Florida or any other state to become so deeply involved with the new curricula in science. Just how deeply our schools are involved does not appear to be generally understood and so it may be well to begin by citing the figures.

The PSSC physics course is presently taught to somewhere around sixty-five hundred of Florida's high school physics students. BSCS biology is being studied by some twelve thousand and CBA and CHEM Study chemistry by perhaps six thousand students. In addition, several thousand students are studying the School Mathematics Study Group program and other new approaches to the teaching of mathematics. More attention has been directed to the PSSC physics course and its place in the science programs of the schools than to any of the others. This may be due to the fact that the sixty-five hundred students represent a majority of those taking high school physics, probably something like 75 percent of the total. In addition, the PSSC program in Florida is older and we have therefore

An earlier report on this subject appeared in the *Educational Services Incorporated Quarterly Report,* Winter-Spring Issue, 1963.

had more opportunity to evaluate its acceptance by both teachers and students and to assess the role of the universities, the State Department of Education, and the public school people in initiating and carrying out a major curriculum change.

The primary purpose of this chapter, then, will be to examine the PSSC program in Florida—why and how it found its way into our schools and to what extent it appears to be serving the ends of good education. A similar but somewhat less thorough examination will be made of the programs in biology and chemistry. Their educational goals and the manner of the implementation of the courses in the schools have been generally similar to those of PSSC physics. For those who are interested in the merits of a large-scale introduction of the new curricula in science, information will be provided on the impact of the courses on teachers and students. For those who want information on the procedures of curriculum change in the schools and on the teacher education efforts which have attended the introduction of the courses, the mechanics of the operation will be described.

Why and How?

The expressions of interest have most frequently appeared in the form of two questions. The first is, "Why did you do it? Why has Florida gone over so heavily to the new secondary school curriculum programs, especially PSSC physics?" And the second is, "How did you do it? How was such a major change in curriculum brought about in so short a period of time?"

Let us consider these questions in turn. No single person can speak with authority for all of the school people in Florida who have been part of the effort over the past four years, but there are several factors which stand out and upon the importance of which nearly all concerned would agree. In the first place, those in positions of leadership in science education have taken seriously their responsibilities to the public schools in the matter of curriculum. This means that new ideas and new materials are examined closely and their meaning for the education of Florida's youngsters carefully assessed. In the case of PSSC physics, this was done almost from the beginning. In the early stages of its development, the work of the Committee became a matter of deep interest to a number of educators and scientists in Florida, as it did to many others concerned with science education, and we felt that serious thought should be given by the PSSC group and by school people of the state to trying the course out in a number of our schools. The reasons for this decision are generally those that have been advanced by others in support of the PSSC course: its inclusion of important topics from modern physics built into the course rather than added on at the end; the deletion of much of the trivia which had been emphasized so heavily in many traditional textbooks; the availability of a laboratory program, films, and books for corollary readings which were, in our opinion, superior to existing materials; and a teacher's guide which appeared to be genuinely helpful to the teacher.[1]

There were several other factors which appear now to have influenced the decision to try PSSC physics. These have to do with such things as the educational climate in Florida but these more nearly answer the question how than why. In the end, those responsible for the decision and the action in 1958 and 1959 believed that the PSSC course would provide better education for our students than the courses being taught in most of our schools. The question then became one of taking the new course to the schools.

Now the second question: How was it done?

In the early fall of 1958, plans were initiated at the Florida State University by the Departments of Physics and Science Education to make available to the high school physics teachers a special course built around the approach of the PSSC and to make it possible for those teachers who would like to do so to introduce the course in their schools in September, 1959. During the fall and winter, there were several meetings and numerous communications between the University and the PSSC staff which served to modify and refine the plan being developed for Florida. It must be remembered that in the fall of 1958 the course was in a highly preliminary condition and was being used only in selected schools and in modest numbers. Florida was proposing that the course be offered to any school whose physics teacher would take the special preparation and whose principal would agree to provide the textbooks and laboratory guides. (The laboratory equipment was obtained from National Defense Education Act funds set aside especially for this purpose by the State Department of Education.) The implications of such a plan were plain: if the implementation were handled poorly—for example, if the teachers were improperly prepared or the laboratories inadequately equipped—the results of the Florida experiment might well be such as to reflect unfavorably—and unfairly—on the whole PSSC project. It was therefore only after lengthy deliberation that the PSSC staff and the University agreed that the project for Florida was a reasonable undertaking, that the potential gains in improved physics instruction for our students justified taking certain risks.

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[1] The particular merits of the PSSC course have been discussed more fully in the periodical literature articles by Gilbert Finlay, Frederick Ferris, Elbert P. Little, Francis Friedman, and others.

Another factor which helped to determine the method of operation and which influenced the parties both in Watertown and at Florida State University in their decision to proceed was the educational climate in the state. Public education in Florida came of age only in 1947 with the adoption by the Legislature of the Minimum Foundation Program of state support for the public schools. The forward momentum of education following its adoption was still strong in 1958 and the eagerness of school people to move ahead was clearly evident. The State Department of Education had just appointed a science supervisor and it was his job to encourage the schools to take whatever action was needed to improve their science programs. In doing this, he sought the support of the colleges and universities at every point where they could be of service. Thus the Department of Education participated in the plan from the beginning and helped to establish contacts with school administrators in particular which were so important in a later phase of the project. The close cooperation between the Department of Education and other educational agencies—in this case Florida State University—has helped immeasurably in the progress of education throughout the state.

The Operational Plan

It was determined that the introduction of the PSSC course should proceed in three stages: (1) providing special training in the

PSSC approach for those who would conduct the teacher education program, (2) training the high school teachers who would teach the course, and (3) assisting the schools in taking the necessary steps to offer the course in the fall of 1959.

But even before beginning the orientation program for those who would teach the teachers, it was necessary to lay careful and detailed plans for the teacher training program. An application to the National Science Foundation requesting support for three in-service institutes to operate during the 1959–1960 school year was submitted in November, 1958, and approved in March, 1959. The institutes were to be located in: (1) Miami, to serve only the schools of Dade County, (2) Bradenton, to serve eight counties in the Tampa Bay area, and (3) Jacksonville, to serve seven counties in the northeast section of the state.[2] Meanwhile, the question of how those who would conduct the in-service institutes might be oriented was being discussed since it was considered essential that the instructors understand thoroughly the philosophy underlying the PSSC approach. This problem was solved early and easily with the decision by PSSC to hold a special conference in June, 1959, at MIT, primarily for those who would teach in the 1959 summer institutes for high school teachers. The University faculty members who would serve as instructors for the Florida in-service institutes beginning in the fall were to be included.

The second and most critical phase of the project was carried out in April and May. The writer, who had been designated as Director of the project, considered it essential to meet face to face with a representative of the superintendent of schools in each county to be served by an institute along with the science supervisor and as many physics teachers as possible. In retrospect, these meetings appear to have been of prime importance in the success of the project. The majority of the physics teachers were, at best, only slightly acquainted with the PSSC program; the supervisors and administrators were likewise only vaguely aware of "something going on at MIT." Both groups were, however, eager to learn more about it. Considerable time, therefore, was spent in discussing the new course—how it differed from the one they were teaching, the requirements for participation in an institute, requirements for those who would teach the course in their schools, and similar matters. In addition, the school administrators were concerned about how the new course would fit into the total science program, how parents would react, how the students who studied PSSC physics would fare on the College Entrance Exams and in the study of physics in college. The answers to some of these questions, in 1959, could only be guessed at; it may be that the teachers and the school administrators were expressing their confidence in Florida State University and the State Department of Education in their eagerness to try out the PSSC course. Whether their decisions to go along—and there was near unanimity among the schools located in the areas served by the institutes—were really due to faith in the educational leadership or to dissatisfaction with the physics then being given in the schools is a question which will likely remain unanswered.

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[2] In Florida, the unit for the organization and administration of the public schools is the county. There are 67 counties—thus only 67 school districts.

There were questions, too, about all manner of mechanical details: what equipment would be required, how much would it cost, who would pay for it, when and where would the classes be held, would non-physics teachers be accepted, and many others. In describing the PSSC operation to educators in other states who have been looking for a model, we have identified the information-organization meetings as one of the most important elements in the operation of the PSSC project in Florida. The questions listed above are typical of the kinds of things which are important to school people. No matter what educational benefits a program may have, it must be workable in terms of the school's operational procedures to be accepted. It is true that changes in operating procedures can be made but school administrators are understandably reluctant to tamper with so important an element in their schools as curriculum without first being convinced of the need for change, of the potential merits of what is being recommended. In this, they are not greatly different from college or university faculty who regard their own classrooms as domains which an intruder invades at his peril. Education is often accused of being hidebound, of serving as a slave to tradition, and educators of being timid souls who want nothing more than to leave the boat unrocked. That there is some validity to this charge can hardly be questioned—yet it may be this very inertia which has given stability to American education and perhaps even in some measure to American democracy. In view of the number and kind of questions asked at the planning meetings, the requested information could never have been provided by mail or phone. *As a general rule, university faculty members who originate new programs to operate with the public schools would probably do well to consider some sort of face-to-face question-and-answer meeting well before the program is to begin.* This recommendation is made with the full knowledge that such meetings may be difficult to arrange and they take a great deal of time. But if the efforts of those who are to conduct teacher-education programs and who work for the implementation of new curricula are to produce lasting results, painstaking attention must be given to this phase of the project. Teachers and administrators are typically staunch allies of the university scientist-educators but in cases where the school people have had little opportunity to acquaint themselves with the innovations —as in the case of PSSC physics—the information-organization function takes on great importance.

In summary, the following description of the institutes was given to those who attended the meetings:

1. To be eligible, a teacher must be scheduled to teach physics during the 1959–1960 school year and must meet the usual requirements for participation in NSF institutes. Participants would receive the usual stipends provided by NSF for in-service institute participation.

2. Teachers would be encouraged to teach the course to their students beginning in September. In view of the small lead time before the opening of school, the project Director and other institute faculty would work with the schools in ordering books and laboratory equipment, and in making other necessary arrangements to give the new course.

3. In schools where the course was to be taught, the county board of education must purchase textbooks, laboratory guides, and must rent the films; non-expendable laboratory equipment would be purchased with Title III NDEA funds as a special project at the state level. (In this sense, the equipment was "free" to the counties—that is, the cost was not charged against each county's share of Title III funds. The point that some schools may have participated in the project at least partly to acquire some free equipment is probably well made.)

4. The institutes would operate full-time during the last two weeks in August before the schools opened; thereafter weekly meetings would be held for thirty weeks running from early September until late May.

5. The course for teachers would, insofar as possible, be taught as a

similar course would be on the campus; that is, it would be devoted mainly to a study of the physics itself but with rather heavy emphasis on pedagogy and the philosophy of the PSSC approach. The instructor would attempt to exploit the questions and comments of the teachers as an approach to pedagogical method. Acquainting the teachers with the laboratory experiments, sometimes by having the teachers do them and at other times by observing demonstrations, viewing the films, discussing the text, and solving problems and questions at the ends of the textbook chapters would consume most of the time of the institute classes.

6. The course would be designated as a special course in physics for teachers for which six semester hours of graduate credit would be awarded to those completing the course successfully. The credit in most cases could be applied toward a master's degree in science education.

The institutes began operating about two weeks before the opening of school which, in Florida as elsewhere, generally comes the day after Labor Day. Such an arrangement in Florida is an easy matter since the teachers are typically employed for about two weeks before school opens in the fall and again for a like period following the closing of the schools in the spring. This period of study—about six hours daily of lecture, discussion, and laboratory work—was crucial since it enabled the teachers to get several good jumps ahead of their students before school opened. From that point on through the year, the gap between the teachers in the institutes and the students in their classes slowly closed until, at the end of the school year, the teachers scarcely beat their students to the end of the book. It was planned that way.

Merits of In-Service Institutes

There appear to be a number of advantages to the approach described above as a way of introducing new curricula and providing the accompanying teacher education:

1. The need to master the material in order to teach it to his own students is an unusually strong motivating force for the teacher. It is the immediacy of the learning-teaching situation which marks the great difference between the in-service institute in which the teacher is simultaneously teaching the material he learns, and the summer institute in which his newly acquired knowledge is not transmitted to his students for at least several weeks.

2. Related to the above is the availability of immediate help for the teacher in finding answers to the day-to-day problems of teaching. It has been our observation that teachers find a good deal of security in knowing that once each week they will have opportunity to bring their questions —relating both to physics and to the problems of teaching—to the attention of the instructor and their colleagues. The suggestions which result from such discussions are typically very helpful.

3. A close working relationship between the University and the public schools is fostered. During the year, the institute faculty made periodic visits to the classrooms of the teachers and talked with their students and, in many cases, the school administrators about the PSSC course. They met with PTA's and other groups of school patrons in an effort to develop an understanding of the new physics by the school community. The institutes presented an unusual opportunity on the part of the faculty to take the University to the people and this too was related to the introduction of the new course in the schools; it could not have been accomplished in the same manner simply by teaching an off-campus course in the usual fashion.

On the basis of a highly favorable acceptance of the course both by the teachers and their students (see account of evaluation below) as viewed by the institute faculty and in response to numerous requests from throughout the state, the decision was made in the spring of 1960 to offer this same package—that is, the in-service institutes and the assistance to schools desiring to introduce the PSSC course—to other regions in the state not served by the 1959–1960 institutes. Thus, in 1960–1961, six additional institutes were conducted. These were located in Pensacola, Tallahassee, Gainesville, Tampa, West Palm Beach, and Winter Park. These six institutes served 124 additional teachers, the majority of whom taught the PSSC course in their schools. Thus through the nine in-service institutes conducted during the 1959–1961 period, some 210 teachers were given the opportunity to study the PSSC course and during 1960–1961 the course was being studied by about 6500 students.

Evaluating the Project

The project director and other institute faculty employed several different methods to evaluate the effectiveness of the new course with the teachers and their students. A large number of the Florida students participated in the PSSC testing program conducted by Educational Testing Service and reported in the literature by Mr. Fred Ferris of ETS. Various methods were used with the teachers. In the spring of 1960, toward the end of the first year's experience with the course, the teachers were asked to fill out a questionnaire in which they were to evaluate ten different aspects of the course, including the logical order in which the topics are taken up, the usefulness of the end-of-chapter problems, the value of the laboratory experiments, the time available to cover the entire course, the apparent reactions of their students, and other things. 65 percent of the teachers completed the questionnaire which was sent to their schools and which did not require identification by the respondent. The choices in response to each of the ten major questions were "excellent," "good," "fair," "poor," and "bad." 82 percent of all opinions expressed were "excellent" or "good"; 15 percent were "fair," and 3 percent "poor." There were no "bad" opinions registered.

The writer is aware that a survey of this kind has limited meaning, that Hawthorne effect and other things may well have entered but it is difficult to believe that the survey did not have some value. Surely a general response of such an affirmative nature indicates some degree of general enthusiasm for the PSSC course.

As a means of evaluating further the total PSSC operation in Florida, a two-day conference was held in Melbourne in April of 1961 to which both the first-year and second-year PSSC teachers and their principals were invited. Its major purpose was to give the teachers an opportunity to register their views of the course and to provide the teachers from both years, along with their principals, an opportunity to suggest what direction the teaching of physics in Florida might take in the period ahead. During the second day of the conference the teachers and principals met in small groups for discussion, with no more than a dozen people in any group. The records of these discussions were studied by all of those concerned with the PSSC project in Florida. The comments of the participants leave no doubt that the majority opinion favors the PSSC course. Such comments as "A challenge to both students and teachers," "The text is superior to any I have used before," and "Student reaction to the course gets better as the year progresses" were commonplace.

During the 1961–1962 school year, we undertook to follow into college a large number of students who had recently graduated from the high schools of the state. The primary purpose of the study was to compare the achievement of the PSSC-trained students in college physics or physical science with that of the students who had taken the traditional course.

The study was conducted as follows:

1. Each of the institutions of higher education in Florida was asked to supply a list of students currently taking physics or physical science.
2. Upon receipt of these lists, the director of the study compiled a master list and collected certain information on all of the students, including their scores on the ACE Psychological Examination given as part of the Florida Twelfth Grade Testing Program for all high school seniors; also their scores on the mathematics and natural science sections of the Twelfth Grade Tests, and their total scores. This information would later enable us to relate success in college physics, or the lack of it, to certain variables in the students' backgrounds.
3. Each student identified in step one was contacted by mail and asked to fill out a questionnaire providing information on such things as the high school he attended, the kind of physics course taken and his grade, amount of mathematics taken in high school, intended major in college, amount of outside reading the student did in high school, his own estimate of the value of his high school physics course as preparation for college physics, and other things.
4. Lists of students were then sent back to the physics departments for recording end-of-course grades and these returned to the director of the study.
5. Data are now being analyzed to determine the relative achievement of PSSC vs. other physics students in college physics or physical science, and other things.

Some findings based on a preliminary analysis of the data are as follows:[3]

1. In answer to the central question of the study, there is no significant difference in end-of-course grades between those who studied PSSC physics in high school and those who took the traditional course (chi-square test of significance at the .05 level) when the total groups are compared.
2. There are significant differences when various sub-groups are com-

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[3] The information given here is based on an examination of only a small part of the data. A more complete report of the study is now being prepared and will be available to interested parties early in 1963.

pared. For example, among students who scored in the 60th-79th percentile on the ACE test, the mean grade point averages in college physics for PSSC- vs. traditionally-trained students are: for state universities, 2.38 vs. 2.08; for private, four-year colleges, 2.60 vs. 1.73; for junior colleges, 2.33 vs. 2.01; and for all institutions taken together, 2.38 vs. 2.03 in favor of the PSSC students (based on 522 cases). Yet for those who scored in the 95th-99th percentile on the ACE test, the figures are (again PSSC students given first): for state universities, 2.66 vs. 2.56; for private, four-year colleges, 2.50 vs. 2.37; for junior colleges, 2.67 vs. 3.00; and for all institutions together, 2.62 vs. 2.73 (based on 214 students). Note that for the total group, the difference is now in favor of the traditionally-trained student. But it is dangerous to extrapolate. For those who fall in the 0th-59th percentile on the ACE test, the figures are: for state universities, 2.16 vs. 2.18; for private, four-year colleges, 1.25 vs. 1.77; for junior colleges, 2.10 vs. 1.70; and for all institutions, 1.88 vs. 1.87 (based on 736 cases). If there is a pattern here, we have not yet been able to recognize it. There is very little doubt that there are significant differences in grades but that they are being masked by other factors. The task then, as the analysis continues, will be to categorize data in various ways on the basis of the available information and to seek out whatever relationships may be significant.

3. Another observation may be worth noting: students who have had high school physics of whatever kind make significantly better grades in college physics than those who have had none (median GPA of 2.26 for those with physics, 1.94 for those without, based on 2082 cases). This finding has little relevance for the present study and is noted here for the edification of those professors of college physics who still insist that their students would be better off without high school physics. Their grades do not so indicate.

Let us return for a moment to the comparison of grades of PSSC vs. traditionally prepared students. The fact that the PSSC students do not suffer in college physics is somewhat gratifying to those of us who have been involved in the project. There is general agreement that most college physics courses are built along traditional lines and that, chapter for chapter, most college physics texts resemble the traditional high school texts more closely than they do the PSSC text. If this is true, one should hardly expect the student with a PSSC background to outshine his counterpart with a traditional background. We should, instead, probably look to other benefits which the PSSC course offers and rejoice that, having had these, the

PSSC student is still able to match the efforts of his equally-talented, traditionally-prepared classmates in college.

But the question of how the PSSC-trained student would do in a college course which reflects the very best in modern physics teaching is still unanswered. If, as the Commission on College Physics of the AAPT suggests, there are some badly needed changes in the teaching of the general physics courses in the colleges, it would be interesting to see how a PSSC-trained student would do in a really "good" physics course. What is most needed is a measure of the performance of high school students with both kinds of preparation against an independent criterion—one not favoring any special "brand" of physics but simply the best course in physics our very best physicists could design.

The Other New Programs

The plan which was employed for PSSC physics was used with only slight changes for introducing the new courses in biology and chemistry to the schools. During the 1961–1962 school year, the Florida State University conducted two off-campus, in-service institutes in biology—in Miami and Bradenton—and one in CBA chemistry at Marianna in rural West Florida. In 1962–1963, a total of four institutes were offered: two in BSCS biology—at St. Petersburg and West Palm Beach—and one in CHEM Study chemistry in Miami. There has been wide geographical coverage of the state along with efforts to offer the new courses to teachers in our best and weakest schools alike.

The principal difference between the PSSC physics operation and those in biology and chemistry has been in the thoroughness of pre-institute orientation for the public school people. Whereas with PSSC physics, they had heard very little about the new course and how a particular school might adopt it, in the cases of the biology and chemistry programs two years later, information had been widely disseminated by the parent organizations and Florida teachers and school administrators were generally informed as to the nature and purposes of the new courses. The information-organization meetings were nevertheless conducted as before but they were not so well attended nor did the institute faculty and the director find it necessary to make so thorough a presentation.

An additional factor in the success of the biology and chemistry institutes doubtless was the precedent set by the PSSC physics. The point has often been made that the general level of science education in the public schools of Florida was raised significantly by the nine in-service institutes in physics during the period 1959–1961; that the interest of the teachers of the other sciences was sharpened by the enthusiastic reception of the physics program. While it would be difficult to measure any such gain, a number of the school science supervisors and most of the faculty who taught in the institutes have suggested that such was probably the case.

The BSCS biology institutes utilized a team approach to instruction which differed from that used for chemistry or physics. The regular instructors were augmented by faculty members from the Department of Biological Sciences who attended about every fifth institute class. In this way it was possible to bring to the institute specialists in the various branches of biology appropriate to the BSCS course. Special research interests of the faculty were explained and demonstrated and in many cases, the visit resulted in laboratory materials and advice being provided the teachers by the visiting biologist. The chemistry and physics courses seem to lend themselves less readily to this approach—nevertheless consideration is now being given to trying a modification of the team system in future institutes in those fields.

Some Observations

Based on their experience with sixteen in-service institutes conducted in the 1959–1963 period (in addition to nine in physics, two in chemistry, and four in biology, an institute in physical science was given in 1961–1962 for the junior high school science teachers of the Cape Canaveral area), several things stand out. As stated earlier, there are reasons why in-service institutes appear to enjoy certain advantages over summer institutes. Where the institute is designed to enable teachers to introduce a new course in their schools, the in-service program can be directed to that end specifically and the teachers are able to profit from the weekly classes in a special way. But beyond this, the "saturation effect" of institutes—whether in-service or summer—appears to have special merit. In this type of program, a given area is saturated—that is, the institute is open only to teachers from a specified geographical area (usually contiguous with county school district boundaries) and as a consequence, the great majority of the eligible teachers participate. This in turn makes possible the following:

1. Teachers can meet informally in small groups to study together, perform laboratory experiments and demonstrations, and to make preparations for their classes. In one instance, a teacher who had a stronger-than-average background along with unique leadership qualities presided over a Saturday morning study session which met in his classroom—and which was organized entirely on the initiative of the half dozen teachers who participated. The institute instructor suggested special assignments and reference sources beyond those given the rest of the class.

2. School principals and supervisors are able to participate in the institutes and the new courses which may accompany them. There is no doubt among those familiar with the public schools in this country of the central role which administrators play in curriculum change; it follows, therefore, that they must be involved at every step of the way if such changes are to be made successfully. In all of the in-service institutes conducted by the Florida State University, school administrators and supervisors have been encouraged to participate, generally on an informal, non-credit basis. In several, the science supervisors have attended regularly; in others they have come periodically but have stayed in close touch with the teachers through frequent visits to their classrooms. In still another case, a high school principal attended regularly and participated in all of the class activities including homework assignments. The enthusiasm which this man displayed for the work of the institute and the new developments in science curriculum can only be described as an inspiration to the fine teachers from his school—and very likely to those from other schools as well.

3. As a means of solving one of the most serious problems of off-campus classes—that of travel to and from the weekly classes by University faculty—a plan was worked out by which the county school districts would make a contribution toward operational costs. Starting with the 1959–1960 institutes, the participating counties have contributed seventy-five dollars per teacher. While not a large sum, it has enabled the proposals submitted by the University to show a per-participant figure in line with those for on-campus institutes where travel costs are negligible, a factor of some interest to the National Science Foundation.

There may be other advantages too. The fact that the schools have a financial investment fosters interest in various ways including the participation of school administrators as described above and their willingness to spend money for laboratory equipment, books, and other things.

4. The involvement of administrators, teachers, and students in a common effort under the direction of the University tends to strengthen the bond between the public schools and the University. This is a matter of some importance and of numerous benefits for both parties; and if, as in this case, the University is a state supported institution, the relationship takes on special importance.

Many observers have commented on the appropriateness of the new courses in science for average or below-average students. Those who have developed the new programs have stated repeatedly that they have aimed at the level of those who typically take physics and chemistry and biology in our high schools and they have conceded that still other new programs for students of different abilities should be prepared. There is no quarrel with this position for surely one of the great shortcomings of education has been our failure to provide adequately for individual differences among students. Yet the observation has been made in Florida's schools by those close to science education that the teacher is the most important determinant of success where the new curricula have been introduced. If the teacher has had reasonably good training in science and has developed a good understanding of children and how they behave in the learning situation—and if this scientist-teacher is genuinely enthusiastic about both his subject and his students, the ability level of the students takes on secondary importance. There are numerous ways to modify the course, by skipping over some chapters in the textbook and introducing reading materials from other sources, by selecting and modifying the laboratory experiments, and by exercising in numerous ways the good judgment which characterizes good teaching. Of all the ingredients which go into good teaching, the factor of teacher enthusiasm is perhaps most often underestimated. If the experience with the new courses in Florida has any meaning, it is that more of our youngsters can benefit from the new curricula than we had previously believed.

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The American Council of Learned Societies and Curriculum Revision

GORDON B. TURNER · AMERICAN COUNCIL OF LEARNED SOCIETIES

A thoroughgoing revision of the humanities and social studies curriculum is now getting under way for the first time in over forty years. Considering the complexities of the task and the enormous quantities of time, manpower, and money that will be expended in the undertaking, it is unlikely that another major revision will be launched in this century. This is a sobering thought, for even if the nation's finest intellectual talents, pedagogical experience, and administrative skills are brought to bear upon this effort, there is no guarantee that a curriculum can be devised that will be adaptable to the changes that will occur over such a period of time.

Fortunately, there is no need to plan, as some nations must, in terms of a uniform national curriculum. The decentralized nature of the American educational system would not permit it, and it would be a tragic mistake to attempt it. Not only is diversity desirable in a democratic country which seeks to educate all children to the level of their ability, but it is certain that any effort to create a single "ideal" curriculum would fail in the face of strong differences of opinion among the experts on just what the curriculum should be.

It is fortunate also that a large number of institutions, groups, and individuals have been drawn into this task, some working independently and others in various cooperative ventures. These range from individual schools to national educational organizations. They range from individual teachers and scholars to the professional associations of which they are members. This chapter, however, deals only with the activities in which the American Council of Learned Societies has been engaged directly or peripherally through the independent work of some of its constituent societies. It gives a brief historical and descriptive account of these activities, sets forth the major problems encountered in revising the curriculum in the social studies and to a lesser extent in the humanities, and it presents the current state of thinking in regard to those revisions with which it is concerned.

The ACLS took its first step into the arena of secondary education ten years ago when it decided to do what it could, as a federation of professional societies concerned with the humanities and the social sciences, to encourage its constituent societies to turn their attention to the problems of the schools. This decision was based upon the realization that a gulf existed between the results of advanced research in its areas of interest and what was being taught below the college level, and upon a conviction that this gulf would continue to widen unless the learned societies and individual scholars could be induced to take an active, professional interest in the schools. Some societies, such as the American Historical Association, the American Political Science Association, and the Modern Language Association of America, had long been active in this sphere because history, civics, language, and literature had been core subjects in the school curriculum for years. Most societies, however, had been relatively inactive or had failed to take any interest whatsoever in pre-college education.

It was natural, therefore, as the societies became increasingly aware of their responsibilities, that they should move in a variety of directions. The American Philological Society, for example, showed greatest concern about the teacher shortage and the decreasing enrollment in classical languages. The Modern Language Association turned its attention to the modern foreign languages which were at that time on the upswing in the schools and, with the passage of the National Defense Education Act, it joined the government in retraining teachers to handle the increasing flow of students. Other societies, such as the American Historical Association, viewed their main task as one of bringing reading materials and teachers up to date on the latest developments in their fields. Still others, particularly in the social sciences, were concerned either with recruitment of young people into their ranks or with the amount of misinformation about their disciplines that was being presented in the schools. And, finally, there were several societies which initially were unable to define any role for themselves because they could see little of common concern between their own disciplines and subjects taught in the schools, or because, as specialists in graduate and post-graduate research, they did not feel qualified to give advice to schoolmen.[1]

The ACLS was undergoing a similar experience during these first years. It was feeling its way and attempting to identify in specific terms just what "the problems" of the schools were that the Council might help to solve. To this end it held a variety of panels and conferences which brought teachers and scholars together to discuss matters of mutual interest and to recommend appropriate courses of action. It sponsored summer institutes for high school teachers in history and the humanistic subjects in order to acquaint teachers with the latest information about their subjects and to work out ways to include new materials in the curriculum.[2] And it began to familiarize itself with the myriad institutions and organizations in existence which devote themselves consistently and exclusively to educational matters at the pre-college level. The 1950's were then, both for the ACLS and for the societies associated with it, a period of awakening, of hesitant first steps; of seeking to define the basic job that needed the assistance of the scholars and of their professional societies. It was not until the late 1950's, and for some societies the first two years of the 1960's, that it became evident that curriculum revision, with all that the term implies, was the task of most immediate and pressing importance. Teacher education, recruitment of talent into the scholarly professions, better instruction in existing courses are all important, but the first step in any major program of reform, upon which all others advance in lock step, is curriculum revision.

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[1] The ACLS *Newsletter*, Vol. XIII, No. 5 (May 1962), contains a more detailed account of these activities.

[2] Articles on the design and results of the institute program are contained in ACLS *Newsletters*, Vol. XI, No. 9 (November 1960) and Vol. XII, No. 10 (December 1961).

Having reached this conclusion, the ACLS decided for a variety of reasons to concentrate its own efforts initially upon the social studies. In the first place, there was more general dissatisfaction with this area of curriculum than with the humanities, and since art, music, and the several languages are taught as separate subjects, it was assumed that the appropriate learned societies could each work on these subjects independently. The social studies, however, are an amalgam of at least seven distinct social sciences, occasionally taught as disciplines but more often in some kind of integrated program that satisfies no one. Coordination in this area therefore was imperative, and this was the kind of role that the Council could play without duplicating the work of its constituent societies.

It was evident from the beginning that disagreement about the purposes that the social studies program is supposed to serve was going to present a major obstacle to curriculum reform. In essence, this disagreement was over the issue of "citizenship" education, with the most unsophisticated advocates insisting that the whole social studies program must be oriented toward creating good and responsible citizens, even to the extent of selecting only that content which will inculcate allegiance to the virtues and values of democracy, and with their boldest antagonists stating that "citizenship" is either a hopeless goal or a dangerous one because it can be used to promote any view on the political spectrum and ultimately to transform education into indoctrination. The more intelligent proponents of "citizenship" education, of course, would not rig the curriculum in so bald a fashion. Some state categorically, however, that the social sciences and the social studies are incompatible, since the former are neutral, beginning as they do in scepticism and selecting their data without regard to personal value commitments, while the latter are concerned with ethical considerations and must serve certain utilitarian purposes to which the school or the community subscribes.

Before any major curricular reform was undertaken it was essential to determine whether such a sharp distinction between the social sciences and the social studies did exist in fact. With this in mind, the ACLS commissioned nine social scientists to formulate the basic content objectives of the social studies as they understood them from the points of view of their own disciplines and areas of specialization, and it asked the National Council for the Social Studies to have a paper prepared setting forth its view on the aims of the social studies. Each scholar was asked first to give his own views on the goals of education and of the social studies in particular, and then to set down what he would like high school graduates to know about his discipline or area. It was hoped that sufficient agreement about educational aims and content objectives would emerge from this preliminary process so that the real work of curriculum revision could get under way at once.

These papers, published under the title, *The Social Studies and the Social Sciences*,[3] cleared away many misconceptions and identified a sufficient area of agreement about goals and content to insure that no insuperable barrier existed to prevent scholars and schoolmen from working together to improve the quality of instruction in the social studies. There is no denying the fact that differences of emphasis exist, and there are even some points of dispute over educational philosophy between behavioral scientists and educators, but none seem to be so basic that they cannot be accommodated.

The NCSS paper, for example, states that "the ultimate goal of education in the social studies is the development of desirable socio-civic behavior," but in listing the behavioral needs of a free society it cites the beliefs of a free people, knowledge, abilities, and skills, and it concludes by asserting that "a primary obligation of education is the development of intellectual competence." In short, "nothing is more important in education today than the development of an informed and intellectually competent citizenry."[4] Few social scientists would disagree fundamentally with this position, provided the "ultimate goal" means the "end product," and the social studies program is not so heavily oriented toward producing a particular pattern of behavior that the several disciplines are subverted in the process. All social scientists want the schools to produce responsible, intelligent citizens; but they believe this is best done by instilling a respect for objective knowledge, by developing the skills essential for independent thinking, and by providing a critical attitude toward generalizations about human behavior.

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[3] Harcourt, Brace & World (New York, 1962), sponsored by the American Council of Learned Societies and National Council for the Social Studies.

[4] *Ibid.*, pp. 290, 292–293.

Again the NCSS paper states that to the extent the social sciences are scientific they are neutral and unconcerned with the ethical considerations involved in the social studies. It is true that the behavioral sciences in particular emphasize the scientific method and are neutral in their search for truth. Nevertheless, almost all social sciences have their humanistic and philosophical aspects, and if they do not deal primarily with ethics and morals, most are deeply concerned with the attitudes and values that make for responsible citizenship. Joseph Strayer, indeed, in the chapter on history, seems almost to paraphrase the NCSS view that the social studies should instill "the beliefs of a free people, knowledge, abilities, and skills." Strayer asserts that the social studies are expected to do three things: (1) teach about widely varying systems of belief and patterns of organization, (2) give the student the essential information about the cultural history of mankind, including particularly the traditions of his own society, and (3) inculcate certain attitudes and skills. Included among "attitudes" are a respect for evidence, tolerance for differing points of view, appreciation of human dignity, a sense of civic responsibility, and devotion to the welfare of one's country. By skills he refers to the techniques of historical method: the ability to discover relevant facts and to organize them into meaningful patterns, the ability to weigh conflicting evidence, discount biased statements, and choose among various interpretations and policies. History is perhaps unique in the range of contributions it can make to the social studies, and this may well be why it is still the core of the curriculum. Yet all the social sciences have something to contribute in all the categories named above.

Writing on the role of political science, Norton Long cautions that citizenship education presents "all the problems of indoctrination and propaganda" on the one hand and "the dangers of a scientific neutrality" on the other, but he believes that the analytical capabilities and perspectives of the social sciences can do much to minimize these hazards. The "milk-and-water moralism" of most civics texts, he insists, will not motivate students to enter community politics. What needs to be imparted is "a body of factual knowledge, a theoretical apparatus for giving order and significance to this knowledge, a methodology of inquiry and verification, and, in addition, a philosophical appreciation of a range of values embodied in the subject matter of the disciplines." What the student needs also is an understanding of a great tradition to which he can adhere, "not in a spirit of uncritical acceptance but as a matter of free and intelligent allegiance." The aim therefore is to apply philosophical and scientific analysis to the process of politics with a grasp of our cultural background. "By teaching the habit of analysis, the demand for evidence, the need for tolerance, and the capacity to develop critically-held standards of judgment, the schools will make their greatest contribution to the future public life of their students."[5]

The economist, Ben Lewis, echoing the views of the National Task Force on Economic Education, certainly saw no incompatibility between his discipline and the social studies. He fully accepted "responsible citizenship" as the content objective of economics in the schools stating flatly that "to enlist the teaching of economics explicitly in the service of citizenship is in no sense to debase economics or to pervert economics as a science." He made it equally clear, however, that a "responsible citizenship" orientation must not be enlisted as "a form of, or as a front for, indoctrination,"[6] for the latter was the "very antithesis" of objective, scientific scholarship. Economics in the schools must not be expected to give pat answers to public problems or rules for correct behavior, and most certainly not advice about the use of credit facilities, installment purchases, or market transactions. Rather, economics in the schools should attempt to provide understanding of broad economic concepts, insight, rationality, and intellectual maturity which are the indispensable qualities of citizenship.

The utilitarian emphasis which frequently marks the social studies was also of concern to the behavioral scientists, as their papers testify. They want their disciplines presented, if at all, as systematic bodies of thought in a manner that will permit students to discover the regularities in the world of man and his institutions, and they want students particularly to learn the methods that are being developed to study human behavior. Sociology as a discipline is subverted, for example, when an analysis of the family is transformed into a course on better family living just as economics would be distorted if it were presented as a sort of consumer's guide For sociologists, study of the family is a systematic analysis of how and why the family gets organized in various ways and the consequences of these modes of organization for other parts of the social system. If this is presented as bits and pieces dealing with marital adjustment or parent-child relationships, instead of placing the study of the family in a larger intellectual framework, the student will never see the significance of the sociologist's work.

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[5] *Ibid.*, pp. 89, 98, 104–105.
[6] *Ibid.*, pp. 107, 116.

There is no doubt, therefore, that there are clear distinctions between the social studies and the behavioral sciences as represented by sociology and psychology, and if the latter are to be included in the social studies program, they should probably be reserved for study in the late high school years. To say, however, that the other social sciences are so scientific and so neutral that they are not concerned with attitudes and values is to misunderstand the nature of these disciplines. The major difference between social studies teachers and social scientists is in the way they deal with attitudes and values; the former are more inclined to "teach" them, the latter prefer the students to discover them for themselves during the process of acquiring a liberal education. This is not a sufficient distinction to keep the two from cooperating in curriculum revision. It is, rather, just enough of a difference to compel teachers and scholars to work together in every phase of the revision process.

This is, indeed, one of the major conclusions of *The Social Studies and the Social Sciences*. The scholars in the disciplines have a great deal to learn about the problems of curriculum in the schools; they must be brought to realize that their objectives as experts in the social science disciplines do not coincide in every respect with those who are concerned with the social studies, and they must collaborate in preparing materials that will present the basic knowledge of their disciplines in a manner suitable for use in the schools. Social studies teachers will also have to reshape their thinking to some extent if they are going to do justice to the new materials and to the students in their charge. And, finally, the professors of education must be brought in early and play a sustained role in the process of curriculum revision, for upon them will fall the burden of educating the next generation of teachers. It will in a very real sense be up to them to insure that the present distinctions between the social studies and the social sciences narrow rather than broaden in the decades ahead, for they are the philosophers of education and the ultimate arbiters of change pertaining to education in the schools.

It was inevitable, when nine social scientists put their minds to what the content objectives of the social studies should be, that they should uncover other sets of problems. If subjects normally reserved for college are to be introduced into the school curriculum, the problem of grade level immediately arises. There is a real question, for example, at what age a child is intellectually prepared to grasp the kinds of abstract concepts that the social science disciplines construct or when he is able to profit by using the research methods of the scholarly disciplines. Mathematicians and scientists had already shown that in their disciplines such matters could be usefully introduced much earlier than previously thought, but some of the social sciences present problems unknown to the more impersonal disciplines. A child may, for example, unduly personalize matters that are presented in sociology or psychology, or he may make direct applications to himself and his environment that are unjustified. The scholars who had to deal with such questions in their papers for the ACLS were generally willing to proceed cautiously on this, taking it for granted that the students could handle such material, provided their teachers were given adequate training first.

Another problem unknown in mathematics and physics but of major importance in the social studies is that the latter must deal with sensitive issues of political, social, and economic policy. The social studies are after all concerned with human life, including its controversies and complexities, and these issues must be faced. Moreover, both for the student as an individual and for society at large, they must be dealt with by teachers who understand them and who bring to bear on them all the objective analysis that the disciplines afford. It is well known, however, that the mores of society, pressures from minority groups, and sometimes sheer ignorance in the lay population, frequently place the social studies teacher in a vulnerable position if he attempts to hew to the line of objectivity in discussing controversial issues. There are communities which render it virtually impossible to analyze dispassionately such issues as the Civil War, the welfare state, race and class differences, communism, and matters of sex. Yet if the social sciences are going to make their maximum contribution to the social studies program, these and a host of other controversial issues must be dealt with in the classroom in an atmosphere of scientific inquiry free from the prejudices, ignorance, and fears that may exist outside the school or in it. This certainly does not mean that current controversies should be deliberately introduced; it simply means that they should not be avoided where discussion may have an educational value or the presentation of the discipline requires it. There will be difficult problems here, but the authors of the ACLS papers preferred to look upon them as challenges to be faced in curriculum revision rather than excuses for inaction and frustration.

A final major problem revealed by the examination of content objectives, and the one that will be by all odds the most difficult for curriculum revisors to solve, is how to reconcile the conflicting claims of so many disciplines in the limited time available. Even if the social studies program is allotted a course a year in the total school curriculum, it is obvious that every discipline cannot be taught, all areas of the world cannot be covered, and not even the desired minimum in each discipline can be presented. Fortunately there are a few things that can be done relatively easily to alleviate the situation. All the authors agreed that to try to do too much is to do nothing well, and therefore each was prepared to discard the hope of covering everything he desired in preference to selected studies in depth. This attitude is the first prerequisite to framing a manageable program. Second, the view frequently expressed, that children are capable of absorbing advanced materials at an earlier age than is presently required of them, gives promise of alleviating the tight time problem. Third, there is a good deal of overlap among the disciplines both in content and in research methods so that the social studies program carefully worked out to avoid duplication can be made to cover many more of the fundamental contributions of each discipline than might be expected. There are, of course, numerous ways in which the curriculum can be organized using various interdisciplinary and multidisciplinary approaches, but in all such efforts the scholars of the pertinent disciplines must come to terms with each other. This will not be easy; it will require a great deal of thought, imagination, and experimentation, and there is no certainty that one approach will prove to be superior to another. In other words, several good ways will probably be found to achieve a coherent organization and sequence of materials, and at this stage no particular approach should be given priority over another.

The Social Studies and the Social Sciences thus called for action along several lines in order to make sure that curriculum revision would produce alternate social studies programs. In accordance with these recommendations the ACLS decided upon three courses of action. It conducted a survey to determine what plans its constituent societies had to undertake curriculum revision in their disciplines. It joined forces with Educational Services Incorporated to sponsor a summer conference of scholars, educators, and school teachers as a first step toward trying to formulate a general design for a K-12 sequence in the humanities and the social studies. And, simultaneously, it commissioned Martin Mayer to survey the present state of the social studies, to identify promising programs of curriculum revision, and to locate those people, particularly social studies teachers, who would be likely participants in any program of revision on which the ACLS might embark.

The survey of constituent societies was revealing in two respects. In the first place, most of them are devoting themselves exclusively to the high school curriculum, although it is in the elementary school that the foundations are laid for all subsequent work. In the second place, it is evident that the greatest progress in curriculum revision is being made in those disciplines that are adequately financed, namely, the behavioral sciences and modern languages. The American Anthropological Association, for example, under a grant from the National Science Foundation, is sponsoring an Anthropology Curriculum Study Project which is hard at work developing new high school courses and materials. The American Sociological Association has drafted a long-range proposal to include the preparation of a high school course in sociology and another in the social or behavioral sciences, and there is good reason to believe that it will soon be adequately funded. The modern languages, with support through the NDEA, the Office of Education, and the College Entrance Examination Board, are receiving extensive treatment. The professional societies dealing with the other humanistic and social science disciplines, however, have made far less progress in actual curriculum revision. The associations dealing with classics, history, and English (at the elementary level) have concrete plans but no funds to implement them. Those concerned with art and music, civics and international relations, have not yet reached the point of framing proposals for thorough curriculum revision, but they have no immediate prospects for funding any plans they may develop. The American Economic Association and the Association of American Geographers have sponsored projects to determine what general concepts and skills in their disciplines are appropriate for inclusion in the schools, but they have not been adequately financed to permit the scholars to work consistently and closely with social studies teachers to develop courses in detail, to prepare accompanying materials, and to test and retest them in the schools. In short, these are not truly joint efforts, for the scholars are unable to give the teachers more than general guidance, and until they do, the revisions will necessarily remain less than adequate.

The conference sponsored by the ACLS and Educational Services Incorporated was held at Endicott House in Dedham, Massachusetts, in June 1962. It was deliberately unstructured because it was believed that the best hope of coming out with a fresh approach to the school curriculum was to give the forty-five participants ample opportunity to confront one another in free-swinging debate and see what dominant ideas would emerge around which a new curriculum might be fashioned. Shortage of funds held the conference down to two weeks duration and deprived it of full representation in the humanities so that nothing so revolutionary as a unifying approach to the entire humanities and social studies curriculum was formulated. Nevertheless, guidelines were developed for structuring substantial segments of the curriculum, and sufficient consensus was achieved in other areas to hold out promise that a coherent K-12 program might ultimately be created.

The first few days were spent in identifying problems and airing differences of opinion, but it soon became apparent that the central question was whether the humanities and the social studies could be streamlined and presented in such a way that students in twelve short years of school could acquire the skills and absorb the knowledge considered essential minimums in the modern world. The conferees believed that they could, provided a thoroughly integrated program could be developed which would be sequential in its offerings, interdisciplinary in nature, and inductive in its method of approach to the disciplines.

This belief was not quickly or easily reached, and even at the end of the conference it was not shared with equal conviction by all participants. Yet most thought the ideas generated at the conference deserved to be developed and tested in the schools, and many were prepared to devote their energies to this end.

There were several reasons for this. In the first place, as the disciplines were discussed in the early days of the conference, and it became clear that each had something of importance to contribute to the school curriculum, all of the participants began to understand the urgency of finding ways of incorporating them in the school program. From this point forward particularism began to give way to cooperative efforts. The humanities and the social sciences after all have a great deal in common, dealing as they do with man, his origins and his achievements, and there should be no reason why a coherent program incorporating both cannot be devised. History and the humanities may be concerned primarily with unique events and with man as a creative individual, while the social and behavioral sciences may deal mainly with generalizations about human and societal behavior and with scientific methods for discovering them, but these are differences of approach which the student needs to understand if he is to be adequately educated. It was not a question therefore in the minds of the conferees of reducing the time available for one in order to make room for the other; it was rather a matter of giving the student a better grasp of both. And this was not to be accomplished by piecemeal revisions but by the development of an ordered, sequential and coherent school program to which the several disciplines would contribute in a variety of appropriate ways.

The one framework to which a majority of the conferees could subscribe on both academic and pedagogic grounds was to begin with man as he first emerged into a distinctive member of the primate family and to advance with him as he continued to develop a unique form of life encompassing the ability to symbolize and to create a complex society. The curriculum would thus be sequential, following in a roughly historical way the growth of man as an artistic and intellectual being, creating a variety of cultures with distinctive political, social, economic and technological systems that can be studied and appreciated. In this way children would begin with man and society in their most primitive and simplest forms, making use of the data, concepts, and techniques of anthropology and related disciplines, and acquiring the basis for further study in later years of more particularized disciplines and more complex civilizations.

A framework which would introduce children in the early grades to the concept of evolution and to the modes of life practiced by hunting and gathering societies would, of course, be a revolutionary one, reversing the standard pedagogic idea that the child must start his education with the known and the familiar and proceed from there to the unknown and the unfamiliar. The conferees, however, shared Jerome Bruner's doubts about the validity of present practice which carries the child progressively from the world of the home and the school to the larger worlds of the neighborhood and the community. They were instead persuaded by his thesis that the child's mind tends to be occupied by his own real world of fantasy and imagination, and they sought to capitalize on this phenomenon.

Bruner's *The Process of Education,* indeed, had a profound influence upon the conferees whenever they dealt with purely pedagogical problems, for his analysis of the development of the learning process seemed to demonstrate that the revision in content desired by the humanists and social scientists was not only feasible but pedagogically sound. Moreover, those participants who had been involved in developing the new physics curriculum had found Bruner's ideas to be successful as they had applied them, and they were eager to have the Endicott House conferees emulate their procedures and methods to the extent that the subject matter of the humanities and social studies would permit.

Bruner, for example, does not believe that learning is a waiting process in which children must at intervals mark time until they mature enough to be introduced to increasingly complex subjects. The foundations of any subject may be taught in some form at any age. Experience over a decade, he says, indicates that "our schools may be wasting precious years by postponing the teaching of many important subjects on the ground that they are too difficult."[7] The fact is that the basic concepts of the sciences can be grasped by children far earlier than has generally been thought possible, and it can be presumed that the same applies to the humanities and the social sciences.

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[7] Jerome S. Bruner, *The Process of Education* (Cambridge, Mass., 1962), p. 12.

These were, of course, encouraging ideas to people struggling with the seemingly impossible task of finding enough time in the school program to accomplish what they considered the bare essentials of education, and the Endicott House conferees were certainly eager to push forward the age level at which serious and significant materials could be presented, if in fact a workable method existed of introducing students at an early age to the systematic bodies of knowledge with which, as humanists and social scientists, they were concerned. They had to be convinced however that the concepts of the verbal disciplines can be grasped by young children as mathematics and the sciences can, and they needed guidance in methods of introducing their disciplines, as disciplines, at any level in the schools. Once again Bruner provided the ideas on which the conference was to proceed.

Learning should never be designed merely for the moment, for the passing of tomorrow's examination as it were; it should also and primarily be designed to enable us to go further more easily at a later date. Of necessity, however, school children get only relatively brief glimpses of all the subjects they have to take, and the problem is what can be done during each of these exposures to learning to make them count in their thinking in later years. The answer in Bruner's words is to give students "an understanding of the fundamental structure of whatever subjects we choose to teach,"[8] and by grasping the structure of a subject he means "understanding it in a way that permits many other things to be related to it meaningfully."[9] If a person is to be able to recognize the applicability of an idea to a new situation, he must understand clearly the nature of the subject with which he is dealing; he must, in other words, have a firm grasp of the underlying principles that give structure to the subject, and "the more fundamental or basic is the idea he has learned . . . the greater will be its breadth of applicability to new problems."[10] Knowledge of specific topics without some structure to tie them together is unlikely to be long remembered, and generalizing from what the student has already learned to what he may meet later becomes impossible. It is known, on the other hand, that one way in which early learning makes later study more effective is through the transfer in the student's mind of principles and attitudes. This type of transfer is at the core of the educational process for it permits him to use a general idea, once mastered, as a basis for seeing subsequent problems as special cases of the idea learned originally. Learning, in short, is not only more efficient but more durable if there is a structure to which specific pieces of information may be attached.

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[8] *Ibid.*, p. 11.

[9] *Ibid.*, p. 7.

[10] *Ibid.*, p. 18.

Redesigning the entire school curriculum so that it will clearly reflect the most profound and pervading ideas and attitudes of the humanistic and social science disciplines is obviously going to be a Herculean task. It required the best minds in mathematics and science to strip their disciplines down to the relatively simple concepts that form their basis. No one doubts that the task of getting at the core of the humanities and social sciences and rewriting teaching materials for them in such a way that their most fundamental themes and concepts are given a central role in the curriculum is going to be equally difficult, and many suspect that it will be infinitely more so. Then to fit these materials to the capacities of children throughout twelve years of school will add unmeasurably to the complexity of the task.

Not the least of the problems is that too little is known about how to teach the fundamental structure of a discipline effectively. Most of the ideas that are basic to the scholarly disciplines will be incomprehensible to young children if they are presented in formal terms or expressed as verbal concepts. It is known that young children learn by action, imagery, and notation in that order, and there is considerable evidence that recapitulating this order is helpful in all learning situations. Simply put, this means that students should not be asked to memorize the laws of science or to commit basic concepts to memory. They should instead be given the raw materials of knowledge, the artifacts or documents or laboratory equipment which the scholar himself uses, and then be asked to see what they can make out of them. The student is not, in other words, to be a passive recipient of knowledge, but an active participant who will learn by doing.

Taking their cue from the experiences of the mathematicians and sciences, the Endicott House conferees expressed the hope, for example, that young children, given replicas of the materials unearthed in archaeological digs and then encouraged to suggest explanations from the evidence in their hands, would not only find existing interpretations more meaningful but would also be getting transferable lessons in methods of research. The conferees assumed, in other words, that carefully designed materials could help students develop ideas for themselves before the generalizations were formally presented to them. The very young child would, of course, have to depend on manual manipulation of his materials and would begin to develop ideas intuitively; as he progressed in years and learning, verbal imagery would replace much of the action. He would begin to make connections and formulate concepts more easily, and would come to see for himself the structure of the discipline. From his continual exploration of the field, it was thought that he would emerge not only with a deeper understanding of basic principles but with the habits of mind and methods of approach which would enable him to make the maximum use of his intellectual capacity and his still limited knowledge.

The conferees were aware of the problematic nature of their assumptions about this so-called inductive approach to learning as it applied to the humanities and the social sciences and particularly as it applied to young children. They were not at all certain that a method of teaching which had been used effectively to introduce advanced mathematics in the elementary schools would achieve similar results with disciplines which rely heavily upon verbal formulations. Yet they were confident that ways could be found to introduce some humanistic concepts in the early grades, and they thought there was a reasonably good chance of introducing students at the same levels to some of the scientific methods used in dealing with the social and behavioral sciences.

Out of all these general agreements—that the school program should be integrated in its over-all framework, interdisciplinary where possible and at all times sequential, presenting the structure and methods of the disciplines, and using the inductive approach to learning—there began to flow a group of specific proposals for action, three of which are now being developed experimentally as rapidly as funds become available. The first and most advanced of these is an elementary sequence, for grades one through six, which explores man's origins and the history of Western man up through Minoan Crete and Mycenean Greece, combining the insights of anthropology, archaeology, history, music, art, and classics, and drawing upon other disciplines where appropriate. It will make extensive use, particularly in the early segments of the sequence, upon specially prepared films of current archaeological expeditions, and upon models of the raw materials of anthropology.

Following this, plans call for a junior high school sequence, the core of which will be an eighth grade course on the 17th and 18th century origins of American culture emphasizing the transition from subject of the Crown to citizen of the United States. The "subject-to-citizen" approach is not a new one. This course, unlike previous ones, however, would draw upon the resources, not just of history, but of all the relevant humanistic and social science disciplines, integrating them carefully in a thoroughly interdisciplinary manner and presenting the materials in depth through a series of case studies comparing analogous situations and events in 17th century England and 18th century America.

This kind of integration of both subject matter and method of approach in the elementary and junior high schools, the conferees believed, would introduce students to the different habits of mind peculiar to each discipline and would lay the foundation for senior high school courses oriented toward individual disciplines or broad disciplinary categories. No agreement was reached at the conference, however, on what the high school curriculum should contain. A group of anthropologists, psychologists, and sociologists believed that an integrated course on the behavioral sciences could be developed successfully for the tenth grade; others feared that the lack of anything resembling a unified body of behavioral science theory or structure would make such an enterprise exceedingly difficult and they preferred to pin their hopes on the preparation of a number of separate social science electives for the twelfth grade. American history was considered essential and an interdisciplinary area studies course appeared to be preferred over world history. But no agreement was reached on any of these or upon whether a modern humanities course would be more appropriate than electives in art, literature, and music, because no clear framework was established for a high school program as had been done for the elementary school sequence and to a lesser degree for the junior high school. A planning committee is working on this problem at the present time, and it is hoped that a second Endicott House conference can be arranged for the summer of 1963 which will be able to construct a spine for at least the social studies program in the high school, building upon the sequences that have gone before.

The first Endicott House conference did however endorse enthusiastically a proposal for an optional six-year classics sequence at the junior-senior high school level. This unit, on which work is just beginning, is based on the conviction that at least some Americans ought to have a personal understanding of the roots of our civilization which are as much embedded in Greece and Rome as in the Anglo-Saxon tradition. The classics, indeed, have a concrete and personal message for young Americans on a wide range of subjects such as freedom and slavery, and the individual and society; and the new techniques of language learning give promise for the first time that students may be brought to experience this message through deep immersion in the languages of the times. Through reading and research in the original texts, students have a real opportunity to establish personal contact not only with the classical authors but with all the facets of classical life from poetry to politics. This will not be easy, but it is encouraging that the social scientists at the conference wholeheartedly endorsed the venture and that the humanists were unwilling to embark on it without having social scientists as critics and participants.

The ACLS would be the first to disclaim that the ideas generated and generally accepted at Endicott House are the only answers to curriculum revision in the humanities and the social studies, but it does believe that they deserve to be developed fully, and it is therefore pushing ahead, in cooperation with ESI along the lines proposed. It is doing so in full realization that some of the pedagogical ideas on which the Endicott House proposals are based may have to be revised. It knows that psychologists of learning, to cite but one example, are in sharp disagreement on the proposition that concepts and generalizations ought to be "discovered" by the student rather than presented to him by more conventional means. And even some of those who are enthusiastic about teaching by discovery in the early grades (in order to insure that students do not grow up as slaves to rules and formulas) are inclined to question a heavy emphasis on the inductive approach in later stages of education. In the first place, there is no proof that the complex and sophisticated concepts of the humanities and social sciences can be grasped as readily by this method as appears to be the case with mathematics and the natural sciences where knowledge can be verified experimentally or by its internal consistency. In the second place, it is probably a slower method of instruction, and since there is little reason to continue it once students have grasped the desired concepts, it may be wiser in the interest of faster progress and hence in economy of time to tend increasingly toward presentation and less toward inductive learning in the later stages of the school curriculum.

The ACLS realizes similarly that the interdisciplinary approach can be carried too far, just as it knows that no single curriculum can do justice to the valid claims of all the disciplines. It is therefore encouraging its constituent societies to continue their own efforts in curriculum revision. Nor does it expect to limit its own activities to a single effort; it is continually seeking and receiving suggestions from its Committee on the Secondary Schools, from its constituency and from special consultants for other promising lines of attack on the complex problems of curriculum revision.

One of these consultants, Martin Mayer, has been referred to previously. The survey he was asked to undertake was designed primarily to provide the Council and the Carnegie Corporation of New York with information about people and projects deserving of support. He was to concentrate upon seeking out scholars, teachers, and school systems engaged in programs to revise the social studies curriculum, and to submit a report of his findings. This he has done, and his recommendations are currently under consideration.

Mayer's function was not to make an exhaustive study nor to present an expert's views on the social studies since he is neither a scholar nor an educator. It was believed, however, that as an acute observer of the contemporary scene, as an independent thinker, and a layman, he might throw some fresh light on the problems of curriculum revision. It is of interest to note that he agrees with most social scientists that the social studies should be taught within the framework of the disciplines they represent. The social studies, as presently conceived, he finds to be "a hodge-podge of irrelevancies," taught unsystematically, thus giving the students no means for clear and valid organization of their own social observations and experiences. Teaching, in his words, ought to be "the reorganization of raw experience in such a way that the human mind will discover the usable patterns of thought called disciplines," and therefore scholars who hope to revise the school curriculum must first set to work to define the basic structure of their disciplines.[11]

During the course of his survey Mayer undertook to examine the mathematics and science reform movements, and he found much in them that the social scientists might profitably use as models of reform. He cautioned, however, that the problems in the social studies are inherently more difficult because several of the social sciences are not self-consistent disciplines and some appear to lack any unifying structure for the students to grasp. This is particularly true of the behavioral sciences which, in his opinion, are short on theories and substantive knowledge, overemphasize the scientific method of investigation, and employ highly specialized terminology.

Anthropology is the only behavioral science that Mayer thinks is likely in the immediate future to make a substantial contribution to the social studies program, and this is so because as a discipline it currently has great intellectual vitality. Anthropologists, not content merely to prescribe content for the schools, are exercising imaginative leadership in searching for new teaching methods and are putting enormous amounts of time and intellectual effort into developing and testing materials appropriate for the school curriculum. This is why, in Mayer's opinion, the Anthropological Curriculum Study Project of the American Anthropological Association and the elementary school sequence projected at Endicott House are such impressive ventures. They are under the direction of "masters" of the discipline who have become fascinated by "the intellectual experience of looking at their field afresh, through the eyes of a beginner," and who are devoting their energies to the task in a manner reminiscent of the mathematics and science reformers.

The failure of some of the other social science disciplines to approach the task of curriculum revision in this way leads Mayer to be less optimistic of results. Unless the best minds in each discipline take the time to clarify and simplify their disciplines for teaching purposes, he says, and unless they are willing to work with teachers and children in developing materials suitable to the inductive approach to learning, little effective work in the social sciences will be done in the schools, and probably none in the elementary grades.

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[11] Statements and quotations are taken from Martin Mayer's confidential report to the ACLS.

Mayer is a professional writer and he intends to publish a book based upon the impressions he gained while conducting his survey for the ACLS. It is unnecessary therefore to set forth his views here in detail. It should be noted, however, that as an educated layman looking at the schools from the outside, he believes that history should continue to be the core of the social studies curriculum. Of all school subjects, he says, "history is most nearly indispensable to education," and it is therefore the most vital area for curriculum revision. "The man who has no interest in history is uneducated and probably uneducable," for no part of human reality can be understood without an examination of the past. With history as a school subject under attack by those who want more room in the curriculum for social and behavioral sciences it is therefore imperative that historians make a concerted effort to render the materials and methods of teaching their subject invulnerable to incursion. Historians recognize this, says Mayer, and despite the meager funds available to them, they have been able to make some improvements in history teaching in recent years. The tasks remaining, however, are enormous, for the amount of knowledge necessary before the student can begin to acquire some sense of the structure and relationships of history is prodigious in comparison to other disciplines, and history cannot be taught intelligently before the child develops a sense of time in mid-elementary school years. Most historians agree that history cannot be "covered," and that they must have the courage to exclude the irrelevant as well as the wisdom to include the essentials. What they have not done yet, in Mayer's opinion, is to attack the pedagogical aspects of presenting history in the schools or, it might be added, to find the financing necessary to make a major assault upon the problems that confront them.

One promising route to the study of history, in the years before the child can handle the idea of chronology, is through the study of archaeology where time sequence is usually given in a visual form through the successive strata on the site, and the question of what can be said on the basis of the material objects present provides an excellent beginning to the nature of evidence. Preliterate societies make fine teaching models for young children precisely because they offer so little evidence that almost everything is relevant, and this is one of the reasons the ACLS-ESI elementary sequence may prove to be successful. When one comes to the study of history, however, where the amount of evidence is overwhelming and the teacher must allot more time to case studies in depth, the less one gains a feeling for the sweep of history, and the more difficult becomes the task of curriculum revision. This is one of the tasks that the ACLS-ESI teams on the junior and senior high school programs are wrestling with currently.

One of the most encouraging signs of eventual success that the ACLS has discovered in the recent past is that some of the best minds in the scholarly disciplines, some of the most talented and experienced teachers in the schools, and some of the finest school systems in the country are eager to devote themselves to the complex task of curriculum revision. It has learned also that those already deeply immersed in it are enthusiastic about the possibilities of effective results because they are in substantial agreement about the kinds of results they wish to achieve. The Social Studies and Humanities Curriculum Program, sponsored by the ACLS and ESI, will not fail, therefore, from lack of talent nor from lack of agreement on what intellectual equipment students ought to have when they emerge from high school.

The students for whom this program is being designed are going to participate as citizens in the institutions of a Western democracy, in increasingly intimate association with societies having very different traditions, and in a world of conflict and rapid change. Accordingly they should be led to understand the relations between the individual and society, the characteristics of societies in general, and the comparisons between them. They should also learn about the historical process of change and specifically about the kinds of problems Western institutions have characteristically encountered. This means that the historical process must not be neglected in the curriculum in favor of studies dealing with the static analysis of social organization at one point in time, for no student today can afford to miss whatever can be learned about social change. Moreover, if students are to think intelligently about society and the participation of individuals in it in a period of dynamic change, they will need to learn some method of picking their way through the welter of facts in order to discover those that are relevant and essential. This means that they must begin to learn the structure of generalizations that is the heart of any science dealing with the behavior of man in society—generalizations, that is to say, about both the structure of societies and their processes of change over time.

Some of these generalizations are concerned with mental processes and should become part of the student's intellectual equipment; others have to do with fundamental attitudes and ought to become part of his character. In other words, by developing men as well as minds, this program seeks to incorporate the goals of both the social studies and the social sciences.

One final point needs to be made about this or any program of curriculum revision that intends to introduce students to the disciplines in a meaningful way. No teaching materials can be devised that will by themselves give students an understanding of the structure and methods of the disciplines, and an intimate connection exists therefore between revision of the curriculum and teacher education. The kind of education required by teachers of the new curriculum was set forth clearly in the report of a Conference on New Directions in Teacher Education, held in February, 1962, and sponsored by the ACLS and the American Association for the Advancement of Science.[12]

The participants of this conference, including scholars representing mathematics and the biological and physical sciences as well as the social sciences and humanities, were firmly of the opinion that the prospective teacher must have a broad liberal arts education, but, like other undergraduates, he must major in a discipline and be given an opportunity for independent inquiry. "By demonstration the teacher must help his students develop a disciplined, independent and critical approach to knowledge. Thus it is essential that his undergraduate education introduce the teacher to this sort of creative scholarship." Moreover, a continuing aim of graduate study for the teacher should be "to deepen understanding of the nature, structure, function, and history (as appropriate) of a given discipline." One of the chief contributions of scholars to teacher education, therefore, is the development of curriculum studies "that will lead to the shaping of coordinated curricula in each of the basic disciplines from the elementary grades through college and graduate schools."

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[12] This report was published in *Science Education News*, published by the American Association for the Advancement of Science, June 1962, the ACLS *Newsletter*, Vol. XIII, No. 6 (October 1962), and it will appear in a forthcoming issue of the *Journal of Teacher Education*.

This is one area of curriculum revision that has not yet received adequate attention. Summer institutes are being held in science, mathematics, and the modern foreign languages under the National Defense Education Act in order to introduce teachers to the spectacular changes in these fields, and it is to be hoped that federal support for institutes in the other disciplines will soon be forthcoming, for if the next generation of teachers is to be adequately prepared to handle the new school programs curriculum revision must be extended beyond the schools to include the programs of higher education.

10

The Curriculum Research and Development Program of the U.S. Office of Education: Project English, Project Social Studies and Beyond

FRANCIS A. J. IANNI · THE COOPERATIVE RESEARCH BRANCH OF THE UNITED STATES OFFICE OF EDUCATION[1]

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The role of the U.S. Office of Education in the development of the new educational curricula is one of relatively recent origin. While it is certainly a valid assumption that the major federal agency charged with responsibility for education should have been actively engaged in curriculum revision programs, until the passage of the National Defense Education Act of 1958, the Office's role was primarily a consultative one. And most often this consultation took the form of the preparation of descriptive studies of curriculum materials prepared by other organizations rather than any direct involvement in curriculum revision programs or research into new curriculum methods.

Actually, however, the interest of the national government in both research and education has a respectable antiquity. While we often assume that governmental interest in educational improvement was launched with Sputnik I, the nation has long encouraged both research and educational enterprise. The creation of the Smithsonian Institution in 1877, the Morrill Act establishing the land-grant colleges in 1862, the founding of the National Academy of Sciences in 1863 and the United States Office of Education in 1867 all give evidence of this concern early in our national history. In more recent years, the emergence of the Office of Naval Research in 1946, the National Institutes of Health in 1938, the National Defense Education Act of 1958, the National Science Foundation in 1950 and the Cooperative Research Program of the United States Office of Education in 1956 are new evidences of continued interest.

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[1] Dr. Ianni contributed to this chapter in his private capacity and no official support or endorsement by the Office of Education is intended or should be inferred.

As one looks back over this chronology, however, one salient fact emerges: in each case the motivating factor, or at least the manifest motivation, has been the enhancement of the national interest or purpose as conceived in broadly utilitarian terms. Thus research in agriculture, stimulated under the Morrill Act and developed under the Hatch Act of 1887 which brought about the agricultural experiment stations, was made palatable to the nation not as science but rather as a means of improving agricultural productivity in both quantity and quality. But while it becomes increasingly possible to obtain congressional approval for research funds for remedial programs for the deaf, the blind, the mentally retarded, the delinquent and even the gifted, appropriations for curriculum research and development in the area of the improvement of the quality of education have been difficult to obtain. Even today, both foreign language and area training programs must be sold to the Congress as a means of bolstering the national defense and of getting on in a world grown perilously small.

Certainly, some of the causes of the failure to view inquiry into educational problems as vital to the national and individual interest are inherent in the lack of drama in educational research—no congressman's daughter has ever died of a split infinitive and who among us is prepared to rally patriotically to the defense of Miss Johnson's home room class. But in large measure, educational research has failed to catch the political and public imagination because it has been unimaginative and, until recent years, almost wholly restricted to doctoral dissertations and small, uninteresting research projects. Think back over the years to the significant innovations in educational practice, and you will find that all too often they grew out of the experience and insight of an individual or the pressure of society rather than the findings of educational research.

The first direct involvement of the Office of Education in the area of curriculum revision came about as an almost indirect result of the National Defense Education Act. Passed in response to the dramatic appeal to catch up with and outstrip the Soviet efforts in education and technology, the Act had several provisions which had important effects on curriculum development. Title III of the Act, for example, provided financial assistance for strengthening science, mathematics, and modern foreign language instruction; Title VII provided for research and experimentation in more effective use of television, radio, motion pictures and related media for education; Title VIII established area vocational education programs; other titles were also aimed at improving instruction. But of all the titles, Title VI, which established the Office's Language Development Program, had the most important implications for curriculum revision.

Under Title VI, the Commissioner of Education is authorized to draw contracts with institutions of higher education for in-service institutes: to improve the skills and effectiveness of elementary and secondary school teachers of modern foreign languages; to establish centers for teaching foreign languages rarely taught in this country, as well as related instruction in history, political science, linguistics, economics, geography, and anthropology; and to stimulate research related to instruction in modern foreign languages. As a result of the provisions of Title VI, curricular materials in modern foreign languages have been continuously developed and over 40 percent of the nation's teachers of these languages have been retrained at institutes utilizing the new materials. While these developments were coming about under the NDEA, there was a second series of events which produced a new program of direct involvement in curriculum research and development through expansion of the Cooperative Research Act of 1954.

The Cooperative Research Program of the Office of Education is a relatively recent addition to the growing number of federal funding programs. The post World War II period ushered in some awarenesses of the great need for adequate research in education and related areas as a basis for sound educational practice. The growing recognition of this need led to the passage of Public Law 531 by the 83rd Congress. This Law, which was signed by the President on July 26, 1954, authorized the Commissioner of Education "to enter into contracts and jointly financed cooperative arrangements with universities and colleges and State educational agencies for the conduct of research, surveys, and demonstrations in the field of education." Although the Law was passed in 1954, funds were not appropriated for its implementation until fiscal year 1957. For the first year of operation, approximately one million dollars was appropriated; for the second year it was increased to \$2.3 million. Since that time, the budgetary appropriations have continued to grow; and in fiscal year 1963, the budget for the Program, exclusive of some special foreign currency items, is \$7 million. The budget requested for 1964 is \$17 million.

In the early years, the Program was focused on ten areas of research interest which the Office of Education considered particularly important, although projects in other areas of education were also supported. In recent years, however, the Program has encouraged and received applications from the wide spectrum of research interests relevant to education. As a result, the research areas serviced by the Program have expanded rapidly; and today research is being supported in many fields of basic knowledge—fields which hold promise of important contributions to educational knowledge. This diversification has led to the involvement of growing numbers of scholars, behavioral and social scientists, who have joined with educational researchers in addressing themselves to the problems of education. Equally as important in its role in attracting new research talent to educational problems, the Program has also served as the primary source for providing research situations for the training of young researchers and the continued support of established researchers.

But despite the obvious promise of the important findings resulting from this research, there is little evidence of any innovative effect on American educational practice. Despite one study which produced an aural method of teaching the blind at four times the rate of Braille, Braille still continues as the principal method of teaching the blind. Despite over seventy major studies of teaching-learning methods, the traditional patterns of the teaching-learning process have remained unchanged except for occasional minor refinements, usually in the direction of reinforcement of existing methods. It soon became obvious that research alone will not bring about educational innovation.

The reasons for this failure to bring about a practical realization of the promise of educational research result from the simple fact that research and development aimed at improving education has usually been at such a basic level that it has never been taken seriously by most educators. This is as much the result of the ineptness and lack of vision of the researcher as it is the product of the educator's notorious tendency to cling tenaciously to the security of old and familiar practices. Until very recently, educational research in English and the social studies, for example, has not been regarded as a respectable field of endeavor by the best scholars in such fields as English, history, geography, economics, anthropology, sociology, and psychology. As a result, the responsibility for educational research in this area was left almost entirely to faculties of education, who have labored valiantly but under great handicaps and with distressingly small results. Faced with the scorn of his more respectable colleagues in the humanities and the natural and social sciences, many educational researchers retreated to the small, manageable research project in an attempt to spread the mantle of science over their efforts. They would pronounce the well defined and exquisitely designed small research project approach as the only scientifically tenable one for research in education.

This project-by-project approach served educational research well as a means of establishing a firm base for the development of techniques, but it was obviously not the best method for bringing about major educational innovation in the schools. A careful scrutiny of research in the physical sciences, medicine, and the behavioral sciences, all of which are certainly further along in the improvement of research techniques than is education, reveals that the project approach loses its utility when it is applied to the resolution of major problems. The project approach has proven most valuable in basic research, where the investigator has a particular hypothesis or series of hypotheses which he desires to test. Thus, the project is essentially a technique for focusing attention on some discrete problem within a relatively narrow area of interest. The identification of a particular strain of virus is an example of the project approach in medical research. A project which seeks to determine the effects of various forms of discipline on student achievement is a similar example from educational research. In both cases the investigator is examining the interaction of variables under relatively controlled conditions. But, because of the very nature of the rigid controls necessary to basic research, the operation of these variables outside the laboratory or the experimental classroom is left unanswered unless basic research findings are field-tested in a variety of situations. And after field-testing they must be demonstrated and eventually disseminated to the practitioners before research can have any impact on practice.

These steps of basic research, field-testing, demonstration and dissemination, along with continuous research planning and development, form the basic steps in the research process. It seems relatively obvious that if new "projects" have to be mounted for each of the four steps in an area of research interest, there must be a significant loss both in time and continuity in research. Our estimate is that at the present time, the time lag between the emergence of a researchable idea and its final dissemination as a usable tool throughout the schools, approaches forty years in the field of education.

The trend in most fields of research has been to move from the project approach to the next stage of research mobilization—program research—where pre-planned, continuous attention, through all steps in the research process is focused on persistent problem areas until solutions are found and translated into practice. Thus, one group of researchers follows a research program from development through demonstration. The intermediate steps of basic research, curriculum development and field testing are also a part of the program. Under ideal conditions, the same team of scholars, research scientists, teachers and school administrators work continuously on all phases of the program. This is not a new idea and we do not suggest that it is the only course for curriculum revision programs; we simply insist that joint efforts by each of the interested parties to the program will help implement the results of research as soon as they are available.

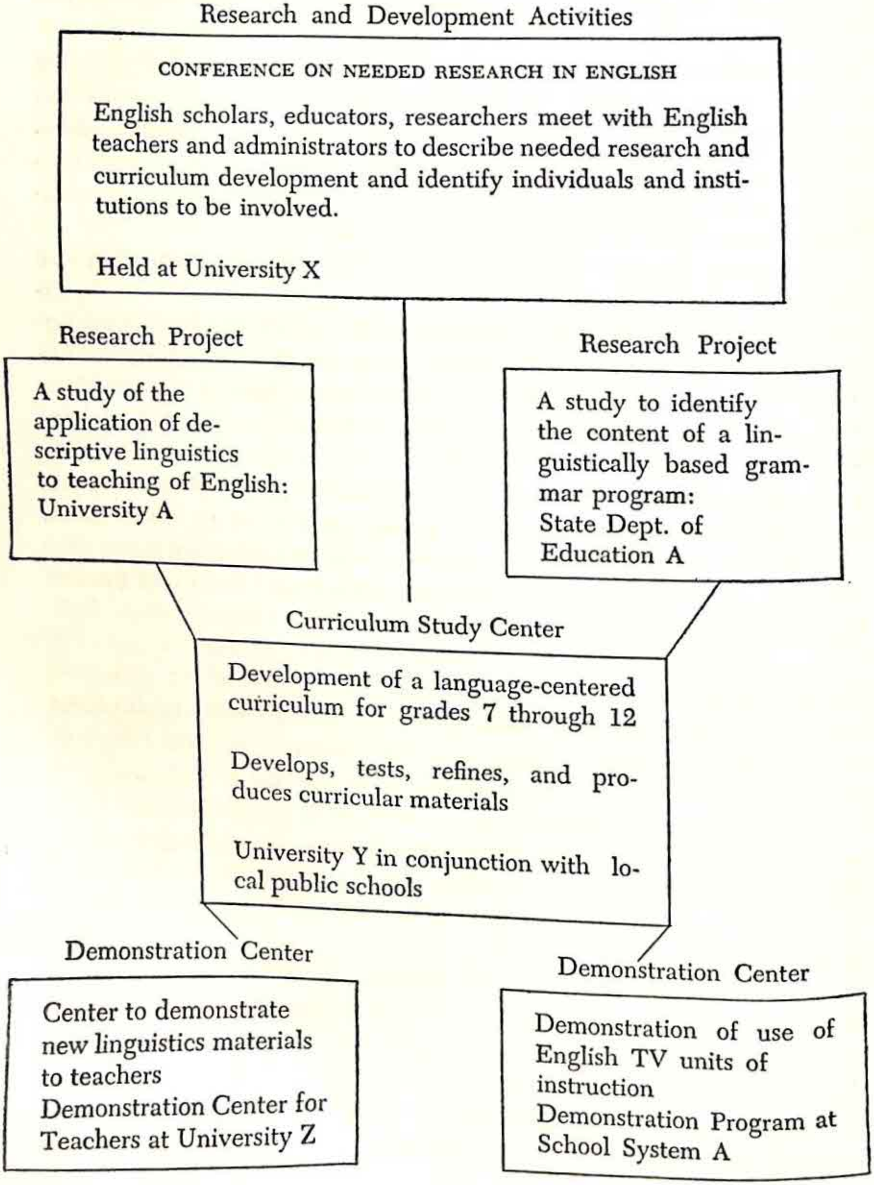
The first steps in this movement within the Office of Education took place in 1962, with the introduction of "programed research" activities in the areas of English and talent development as a means of focusing major attention on these particular problem areas of education. In 1963, a similar programatic approach is being taken to the area of the social studies and in 1964 the same approach in the arts, in teacher education and the learning disorders. In each of these programed areas, funds are or will be available for planning and development programs, basic and applied research, curriculum development, field testing and demonstration, and dissemination. Under the present operational plan, each phase of the research program must be applied for separately; but we are encouraging applications for total programatic support in 1963.

When the programed research activities were first established in the fiscal year 1962, applications were accepted for research development activities such as conferences and seminars, basic and applied research projects, curriculum study centers (designed to develop and test new curricula) and demonstration programs. The diagram below indicates the planned interrelationships among these various types of projects in English.

The first step involved in the planned program was the convening of a conference of English scholars, English educators, researchers, teachers and administrators to review research and curriculum programs in the field of English. The conference also described needed research and curriculum materials as well as identify those individuals and institutions to be involved. Growing out of the conference would be a series of research projects aimed at gathering data on specific problems associated with curriculum development in the field of English. These projects would cover the range of research needs from such basic questions as the relationship between ability in written composition and awareness of grammar in students to surveys of existing research in specialized fields of English. Projects would be established at various universities, colleges, and State departments of education with no necessary relationship among the various projects.

The heart of the new plan, however, would be the establishment of a series of curriculum study centers designed to (1) examine existing curricula in English; (2) design and develop new curricula where needed; (3) test and refine the curricula in actual school situations; and (4) produce and make available on a wide scale new curricula materials. Once the materials are developed they would be

PLANNED RELATIONSHIPS AMONG ACTIVITIES IN PROJECT ENGLISH



Research and Development Activities

CONFERENCE ON NEEDED RESEARCH IN ENGLISH

English scholars, educators, researchers meet with English teachers and administrators to describe needed research and curriculum development and identify individuals and institutions to be involved.

Held at University X

Research Project

A study of the application of descriptive linguistics to teaching of English: University A

Research Project

A study to identify the content of a linguistically based grammar program: State Dept. of Education A

Curriculum Study Center

Development of a language-centered curriculum for grades 7 through 12

Develops, tests, refines, and produces curricular materials

University Y in conjunction with local public schools

Demonstration Center

Center to demonstrate new linguistics materials to teachers
Demonstration Center for Teachers at University Z

Demonstration Center

Demonstration of use of English TV units of instruction
Demonstration Program at School System A

demonstrated to teachers through a series of demonstration centers established throughout the country.

Perhaps the greatest shortcoming of this plan was that each of the phases of the research program—research development, curriculum development, and so on—had to take place almost concurrently at different universities rather than in the continuous program approach which we would have preferred. This was a function of an attempt to get each area of activity off to an early start so that some research results, some curriculum materials and some demonstrations would be available for early use.

In our experience with the first two years of Project English we feel reasonable assurance that this approach has met with great success in both establishing a programatic approach to the development of new curricula in English and in establishing a model for future programatic approaches to other subject areas as well. Whatever its shortcomings and however small the program was at the very beginning materials are being produced and demonstrated in a variety of forms and areas at the present time. This has resulted not only from the enthusiastic response of the English profession and the schools, but also from the fact that the Office of Education was able to back up the impetus of the revolution which had already begun in the field of English.

Project English

The bloodless revolution in English also did not begin with Sputnik; it began with a concept—a concept that the English curriculum demands a concept. No more the rote activity, meaningless and superficial, that looks factually at literature and prescriptively at language. No more the English classroom as the catch-all for whatever is rejected by the other disciplines. As with all revolutions, bloodless or bloody, this one in English began slowly, building on discontent and dissatisfaction, building perhaps in isolated classrooms, perhaps in the mind of a creative teacher, and certainly building momentum in scattered attempts to turn a concept into a reality. But to borrow from T. S. Eliot, "Between the idea/And the reality . . . Falls the Shadow"; and even more significant, "Between the conception/And the creation . . . Falls the Shadow." The revolution is launched; the conception, the idea is formed but it is still a long way to creation or the reality for there are many shadows. But the gap can be narrowed exceedingly, certainly enough to reach some aspects of the conceptual reality, and in the field of English, we move in that direction, a good direction, a positive one. Most vital to that direction is the Project English Program, sponsored by the U.S. Office of Education, a project which assumes great importance in the step-by-step evolvement out of the initial revolution. Before looking closely at how the Project English program has influenced and will continue to influence the changes in the teaching of English, we might first look at what the concept is, how it has evolved, and what progress has been made before government interest. Finally, we may see the possibilities for working toward the whole creation in terms of the Office of Education Program in English, Project English.

We might begin anywhere in the past ten years, perhaps even before, but 1958 and the statements in the "Basic Issues in the Teaching of English"[2] most clearly begins to focus on the need for change. The revolution in these conferences was twofold: they "included academic specialists in English, specialists in the teaching of English in elementary and secondary schools, and secondary school administrators and teachers of English,"[3] and they also suggested issues reflecting dissatisfactions with existing conditions of the English curriculum. Much has been written about these conferences, but most important, emerging from every account of the issues raised, is what Ruth Strickland calls the most crucial issue:

> Probably the most crucial issue raised by the conference is found in the question, "Can basic programs in English be derived that are sequential and cumulative from the kindergarten through the graduate schools?"[4]

Certainly, such a program demands a basic concept upon which the sequence can be based. In this same year, Arno Jewett conducted a nationwide survey in which he discovered trends and interests in the existing curriculum.[5] His survey indicated not only slowly developing changes but also dissatisfaction, the concern for a drastic need for change.

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[2] Members of the American Studies Association; College English Association; Modern Language Association; and NCTE. "The Basic Issues in the Teaching of English." Elementary English Vol. 36, Supplement.

[3] Dorothy M. Fraser, *Current Curriculum Studies in Academic Subjects*, NEA, June, 1962, p. 47.

[4] Ruth Strickland, "Some Basic Issues in the Teaching of English," *An English Teacher's Reader*, Ed. Morton J. Weiss (New York: The Odyssey Press, Inc.), p. 17.

So far we see only a defining of issues. Soon, however, people in English began to be more definite, more specific; individuals and groups began to propose possible ways to initiate change, remove the shadows and bring the concept to a reality. One important group of conferences, the annual Yale Conference in the Teaching of English, considered more definite topics:

> Questions with which the committees were asked to grapple were such as these: What kind of language teaching should be going on in the secondary school? What is grammar? . . . How can writing be taught? What writing skills are most needed? . . . As for literature: How can poetry be taught? . . . How can we rise above the level of teaching only what happens?[6]

The participants wished to define a fundamental approach to the "how" of teaching English. Even more definitive is the report, *The National Interest and the Teaching of English*, published in 1960 by the National Council of Teachers of English. This report seriously asks, "What has to be done about the national need to improve the teaching of English?" then answers its own question in fairly specific terms:

> To focus instruction in English upon the study of language, literature, and composition
>
> To educate teachers of English to the developmental and sequential nature of the study and to institute a national program for encouraging articulation of English studies throughout the school years
>
> To improve present preparatory programs for teachers of English
>
> To improve the preparation of practicing teachers of English

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[5] Current Curriculum Studies in Academic Subjects, p. 43, Dorothy M. Fraser, Report Prepared for NEA Project on Instruction, June, 1962.

[6] *Essays on the Teaching of English*, Ed. Edward Gordon (New York: Appleton-Century-Crofts, Inc., 1960), Preface.

To encourage significant research about the teaching of English

To recruit and prepare more teachers of English[7]

In an effort to implement some of these more specific suggestions, the College Entrance Examination Board spent more than a million dollars on a summer institute program designed for in-service training of teachers at twenty different universities.

So we see the issues defined, the solutions suggested, and some of the suggestions acted upon in what are still limited ways. Certainly, the story is incomplete; more is being done, more important, more must be done. As Jerome Bruner warns, "It would be a great pity if our zeal were too easily assuaged by partial victories. We do well to recall that most revolutions have been lost precisely because they did not go far enough."[8] Hopefully, the revolution in English will continue to move rather than rest contented with what is only a very small and narrow success to date; the concept moves, as yet, only slowly toward the reality. But Project English at the moment takes a logical and significant step forward, a step which seems to be the most positive move in the right direction. Before analyzing the Project English program in terms of its specific significance, it might be well to define first what the new ideas in English are, then what practical proposals exist concerning the workable implementation of these ideas, and finally how they are being actualized in the Project English program.

Again we must begin by reflecting on the importance of a concept. Behind all that is defined as learning in all disciplines, there must be a basic something that is to be learned; Jerome Bruner defines it in terms of the knower:

> The underlying conception is that those who know a subject most deeply know best the great and simple structuring ideas in terms of which instruction must proceed.[9]

Many years before, Matthew Arnold, the great Victorian writer, defined it when he wrote that, "there is, in the generality of mankind, a perpetual tendency to relate them one to another in divers ways."[10] So perhaps we may not say what this concept is any more than we can define English in absolutes; but we can say that behind all teaching and learning of English should lie the importance of a fundamental approach and understanding to what is literature, language and communication, both oral and written. In the approach to these, if that approach seeks to know what Bruner calls the "great and simple structuring ideas," we then may know the concept, illusive as it sometimes seems. In the attempts to reach the reality of the concept, the new approaches in English seem to revolve around three ideas: the inductive teaching and learning of English, the attempt to establish cumulative steps in the English curriculum and finally, the importance of literature, language and communication as integral and interrelated parts of one discipline, one part of which cannot be isolated from another. Let us see, more specifically, what is meant by the inductive method in English, by the possibilities for a sequential program and finally, by the interrelation of the three unique but interdependent aspects of the one discipline.

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[7] "A Report on the Status of the Profession," *The National Interest and the Teaching of English*, NCTE, p. 3.

[8] Jerome S. Bruner, "Introduction: The New Educational Technology," *The American Behavioral Scientist*, Vol. VI, November, 1962, No. 3, p. 8.

[9] *Ibid.*, p. 78.

In an article on *Teaching the Novel,* Paul Pickrel says,

> What I find curiously lacking when I look back upon my experience in high school classes in literature is any suggestion that a novel does anything more than tell a story, that it has, to use the most slippery of words, meaning.[11]

Only through the inductive method can students begin to see the importance of what lies beneath the surface of the work of art. Asking questions that deal only with where a character went or what that character wore simply does not engage the student's powers of perception. Neither do lectures on literary backgrounds, an author's life or the make-up of the Elizabethan stage. What then? Looking to the new critics, we find our direction through the literature itself—through the text, from which, by means of thoughtful questions, part of a carefully structured plan, the teacher may encourage students to induce what is vital to the nature of literature.

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[10] Matthew Arnold, "Literature and Science," *The Portable Matthew Arnold,* Ed. Lionel Trilling (New York: The Viking Portable Library, 1956), p. 416.

[11] Paul Pickrel, "Teaching the Novel: Great Expectations," *Essays on the Teaching of English,* p. 217.

Not only will students then induce the underlying vitality of literature, but they learn to look deeply into the core of any verbal-art form—of any art form, perhaps of anything. To be more specific, in teaching Dickens' *The Tale of Two Cities,* a popular novel for the tenth-grade, formerly, teachers might lecture on the Victorian elements of the novel or on social criticism. If these aspects of this novel are important, and they are, they can be induced from the text itself; no lecture is needed but only a carefully structured method of having students induce what is important from the novel. They must learn to see that important "something" in literature; significantly, they must be induced to see it for as Edwin H. Sauer says, "Literature is something, something demonstrable and teachable, or it is nothing. Many of our students fail to respect literature because they see nothing."[12]

In *The Scholars Look at the Schools,* a report of the Disciplines Seminar of the National Education Association, the section on English recommends the importance of a cumulative approach to literature.

> The revolution has another, and exciting, side: the discovery, through redefinition of the subject, that its essential nature is progressive and cumulative. By its nature, language builds on language and literature builds on literature, even in reaction. Ignoring this basic truth has resulted in inefficiency, in duplication and reiteration, in critical omissions, and in increasing lack of coordination of parts of the English curriculum.[13]

No one English teacher can ever assume that a student knows any one particular novel or play. Even teachers of graduate students cannot make any assumptions. Mythology, for example, is not only the basis for certain aspects of our culture, but myth, as symbol, underlies much of modern literature, actually much of modern art. Certainly, if the teacher of the 12-grade English course discusses *Endymion,* by Keats, she should be able to assume that her students have a certain fundamental understanding of the myth—that is a conceptual knowledge of mythology, if not just the story of this particular myth.

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[12] Edwin H. Sauer, *English in the Secondary School* (New York: Holt, Rinehart and Winston, 1961), p. 5.

[13] *The Scholars Look at the Schools: A Report of the Disciplines Seminar, NEA,* Convened at the NEA Center June 15, 16, and 17, 1961, a Working Paper Prepared for the Project on the Instructional Program of the Public Schools, p. 13.

With language, the revolution is even more startling, but again it is a revolution, still much in the realm of idea; a great shadow falls between the idea and the reality because of still undefined methodology and lack of knowledge on the part of teachers. Generally, we see the inductive method of language in terms of Structural Linguistics as it is described here by Albert H. Marckwardt:

> Linguistics may best be described as a systematic study of language and languages—systematic in the same sense that any science is so termed. Such an approach to language must rest upon a clearly stated set of postulates or assumptions, it must adhere to modes of classification that are mutually exclusive and non-curricular, and must proceed in a fashion that is basically inductive. From this point of view, linguistics is not a body of subject matter to be presented to the elementary or secondary school student but rather an approach, an orientation toward language which should be reflected in textbook materials and classroom procedures.[14]

No more the teaching of prescribed rules of Latin grammar—rules which do not apply to English, a living, growing, moving language. We must, therefore, study language inductively in terms of what the student knows. He speaks English; consequently, he is prepared to analyze that which he uses every day. He is prepared to analyze it inductively if properly guided by what are again a properly structured sequence of questions. Not only is this method inductive, but again as with literature, it must be cumulative. Beginning a study of language at the first grade-level, a student may learn inductively by first looking at the simple structure of his own language needs and capabilities at that level. As he matures, so does his ability to analyze and use what is more complex in language, so that the inductive method becomes a cumulative one in terms of student capability and need. At no time, then, is he told the definition of a noun, even as it used to be defined to make it easier to remember:

[14] Albert H. Marckwardt, Unpublished manuscript, "Implications for Teacher Education of New Curricular Approaches in English and the Foreign Languages," Conference in New York on Teacher Education, January, 1963.

"A noun's a person place or thing,/Like man, house, dog or swing." He may remember the rhyme, but forget the idea because the idea is meaningless. It does not apply to the concept of what the English language is. A noun is a noun only because of its function within a certain sentence. This function can be arrived at inductively from the student's own ability to speak his language, then cumulatively as he matures to become capable of the ever growing complexities in this same ability.

In composition, too, we see the inductive method suggested as best and most effective. According to J. N. Hook,

> As a final trend in the teaching of composition, I must mention the steady increase in inductive teaching.
>
> This means starting with the specific and building up to the generalization. It is the reverse of the old procedure by which a student learned a rule or a definition and then tried to apply it. Working inductively, he looks at a number of samples, figures out the principle for himself, and then applies it. The volumes of the NCTE curriculum series, as well as Robert Pooley's book on teaching grammar and a number of other authoritative sources, strongly recommend inductive teaching.[15]

Rules of composition, then, like rules of grammar, should not be prescribed; rather they should be induced from the writing itself. To again be more specific, if dittoed samples of student writing are analyzed by a class, the students may easily induce problems according to how successfully the paper manages to communicate. If it does not communicate, the reasons for this lack of communication—the principles of composition—can easily be induced as they apply. As Jacques Barzun says, the motive for writing is to be read,[16] and it is this motive that underlies the inductive method of teaching composition.

Barzun also talks about the cumulative approach to composition when, in this same book, he suggests that students write only about that which they are interested in. Certainly, as a child's interests change so should the topics he writes about. Although there are differences from one child to another, still enough chronological sameness exists so that one possibility of a step-by-step approach to composition is through the topic. But even more generally, during a child's complete and over-all education, the process of both oral and written communication should be a cumulative one in terms of goals as they change and as they build. In *English in the Secondary Schools,* Sauer suggests goals in composition as they change and grow and build from junior high school through senior high school. J. N. Hook, in *The Teaching of High School English,*[17] also suggests concrete ways to approach composition in a cumulative fashion.

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[15] J. N. Hook, "Trends in the Teaching of English," *An English Teacher's Reader*, p. 27.

[16] Jacques Barzun, "How to Write and Be Read," *Teacher in America* (Boston: Little, Brown and Co., 1945).

Mr. Sauer also says of English, "I insist on the interrelationship of its parts."[18] We cannot separate literature, language and communication. Language, for example, is a vital aspect of the organic whole of the literary verbal-art form. Perhaps we may view this aspect as a possible cumulative step in the process of complexity, even more specifically, in the study of the nature of poetry. Logically, there is also a relationship between language and communication since language is the means by which we communicate. Nelson Francis in "Linguistics and Composition: The Teacher's Theoretical Training,"[19] discusses some of the interesting possibilities in this area as does John B. Carroll in his article "Psycholinguistics and the Teaching of English Composition."[20] In talking about the writing of grammatical sentences, Mr. Carroll says, that "this is the problem for which linguistic science has seemed to provide a long-sought solution." Both he and Mr. Francis illustrate many workable and sensible ways to integrate the study of written communication and language, both of which gain from the synthesis. Surely, there are many even more subtle ways in which literature, language and communication evolve as necessarily interrelated, as the whole, that is the art of language. But perhaps the most important way, the way that has gained so much momentum in the revolution, is to have students write about the literature they have read. If that literature is meaningful, then students write about something they can know and understand. In addition, if the literature is planned in a sensible sequential order, the written assignments, then, necessarily follow that same order; and they can be structurally analyzed in terms of the complexities of language. The language arts means literature, language and communication; they are three in one.

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[17] J. N. Hook, *The Teaching of High School English* (New York: Ronald Press Company, 1959, Ind. Ed.).

[18] Edwin H. Sauer, *Op. Cit.,* Preface.

[19] W. N. Francis, "Linguistics and Composition: The Teacher's Theoretical Training," in Morton J. Weiss, *Op. Cit.,* p. 259.

[20] John B. Carroll, "Psycholinguistics and the Teaching of English Composition," *Applied English Linguistics,* Ed. Harold B. Allen (New York: Appleton-Century-Crofts, Inc., 1958), p. 322.

But we are still working within the framework of idea, within the framework of the concept. How can we turn the idea into the creation—the concept into a reality in the language arts? In all kinds of books and articles, suggestions emerge as to the "how" of the revolution. These suggestions, although expressed in many different ways, all seem to converge as part of five basic possibilities in the direction of success in removing the shadows. We must find a way to train undergraduate English teaching majors so they will teach according to the new ideas in English. If college teachers of English do nothing but lecture to students on such subjects as, for example, the background of the Elizabethan theater, they in turn will do so with their own students. Somehow an inductive, cumulative and interrelated program in the language arts must be planned for students who will be the future teachers of English. But not only must we properly train the future teachers; we must retrain those teachers who are now working in the schools. We cannot send them back to college; however, we can plan for more and more summer institutes for in-service training. Establishing in-service institutes, then, brings us to a third necessity, that of the importance of cooperation between the colleges and the schools, between subject matter people and education people. James Squire, Executive Secretary of the National Council of Teachers of English, makes this plea forcibly:

> But I am convinced that the promise of improved English teaching will never be realized until all individuals together, and especially the leaders of various factions, are willing to set animosity aside and strive for the common good. I believe that we must find a way to work together with respect and understanding, with a clear recognition of past achievements and past limi-

> tations, and with a realization of the potential contributions of everyone.[21]

And our fourth point determines the way in which all of these people can cooperate. They can do so by planning and developing, as a team, specific materials for new, vital curricula in the language arts. Perhaps our last point combines all other since it concerns a plea for time—time for teachers of English to teach properly and time for teachers, scholars, administrators—time for everyone to help turn the idea into a living creation.

How then, does the Project English Program help to spread the revolution? We might begin by looking at J. N. Hook's explanation of what Project English really is:

> The Office of Education is now making long-range plans for Project English in consultation with representatives of such organizations or groups as the Modern Language Association, the College English Association, the National Council of Teachers of English, organizations of principals, administrators, supervisors, and librarians, the Commission of English of the College Entrance Examination Board, and State educational agencies.
>
> 1. *Curriculum study centers.* These centers will span several grade levels and each is designed to operate for approximately 5 years. They are intended to develop sound patterns for sequential teaching of skills and content in reading worthwhile materials, in language, and in composition, the sequence being based upon both the subject matter and what is known about child growth and development. The centers will test promising practices and materials, make recommendations concerning curriculum, and develop materials adaptable to systematic school and lower year college programs of instruction. The centers are to be funded jointly by the Office and sponsoring colleges, universities or State departments of education.
>
> 2. *Basic and applied research studies.* Through colleges, universities or State educational agencies, individuals or groups may present proposals for research that show promise of contributing to the improvement of instruction in English on any level. A number of such proposals have already been approved by the Cooperative Research Advisory Committee. Under the law, the committee must evaluate and pass upon requests for

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[21] James R. Squire, "English at the Crossroads: The National Interest Report Plus Eighteen," *The English Journal,* Vol. LI, Sept. 1962, No. 6, p. 391.

> centers, research studies, or conferences before any concrete action is taken. Proposals that are most likely to be accepted are those that show promise of improving instruction at any academic level.
>
> 3. *Research planning and development.* Conferences or seminars dealing with needed research in teaching English are arranged through requests submitted by responsible officers of colleges, universities, or State educational agencies.
>
> A number of activities already in progress in or sponsored by the Office of Education will feed results into Project English. Among the many that could be mentioned are studies of reading and summaries of research in reading on the elementary and secondary levels, a detailed analysis of the characteristics of the academically able and a wider study measuring levels of talent of all sorts, a study of curricular offerings and patterns in English and other subjects in colleges and universities, and a clearinghouse of research in higher education.[22]

One year later Mr. Hook reports on progress:

> Project English is already far into the program outlined for it when it began, barely five months ago. The three curriculum study centers provided for in this year's budget have been contracted for; a national conference has been held to identify the problems in greatest need of research; and ten projects (in addition to the centers) have been approved for inclusion in the Office of Education's Cooperative Research Program.[23]

Since this report of Mr. Hook's, three more Curriculum Study Centers have been established and at least two more are planned in 1963. In January of 1963, then, the following curriculum projects are under way:

Carnegie Institute of Technology. CIT plans to develop a curriculum for able college-bound students in grades 10–12 in cooperation with five local high schools. A major goal will be establishment of standards for high schools which will eliminate problems of repetition and overlap.

Northwestern University. Northwestern plans to emphasize the teaching of composition from grade 7 through the sophomore level in college. The program in composition will be related to reading and language study and will be planned in cooperation with many junior and senior high schools in the area.

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[22] J. N. Hook, "Project English: Its Implications for Colleges and Universities," Reprinted from *Higher Education*, April 1962, U.S. Department of HEW, Office of Education.

[23] J. N. Hook, School Life, Official Journal of the Office of Education, "Project English Progress Report," May, 1962.

University of Nebraska. Nebraska's program will cover all grades from kindergarten through the first year of college. Plans call for development of new materials in composition and for the testing of these in primary, junior high, and senior high classes during the next twelve months.

Hunter College. Hunter will develop reading and English language materials for students in grades 7–9 in culturally deprived urban environments.

University of Oregon. Oregon will concentrate on developing a curriculum in language, reading, and written and oral composition for all students in grades 7–12, except for students so slow that they can learn only through a specially planned curriculum.

University of Minnesota. Minnesota plans to identify and analyze informational and conceptual content in English language study and to prepare curricular materials and study guides for teachers of English in grades 7–12.

In addition to these activities, a significant report of the national conference has been prepared for national publication by E. R. Steinberg. The report, *Needed Research in the Teaching of English,* states as its purpose, an attempt "to pull together the thinking and scattered research in the teaching of English, determine the gaps, and point the way for further significant search." Project English, then, is moving forward in many ways with individual projects, but most significant are the Curriculum Study Centers.[24] We might look at them first as they have conceived the concepts, the ideas, then as they are attempting, according to our five criteria, to turn these concepts into a reality.

As before, we may begin with the inductive teaching of literature. We find some very specific examples of this approach in the materials from the Nebraska Curriculum Study Center. Questions addressed to the first grader attempt to induce the relationship of literature to life in a familiar story like Peter Rabbit, for example. Here the first-grader is asked to think about the difference between the character of Peter and that of his less rebellious sisters. Do they listen to their mother because they are girls? How does Mr. MacGregor appear to Peter? Does he remind you of something frightening? These kinds of questions, on a very simple level, allow the child to see that the story is more than just a story. Nebraska also attempts this method with mythology. These questions about Orpheus and Eurydice may well induce an understanding of the relationship between the myth and the real.

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[24] Committee of Seven, *The Study of History in the Schools: Report to the American Historical Association* (New York, 1899).

> Orpheus has achieved fame in mythology for several reasons. List them. Why is the fact that Eurydice dies so suddenly after her marriage important to the story? What feelings did Eurydice's death arouse in Orpheus? How did Orpheus give vent to these feelings? Recall other underworld situations you have met in mythology. How does this underworld incident compare with the others? Is the underworld pictured the same in each story? How does Orpheus show us that he is only human?

If the student sees why Orpheus is only human, he sees into the concept of the myth.

The Curriculum Study Center at Carnegie Institute of Technology also uses the inductive method in the teaching of literature; we can see in its initial plan for the literature course an underlying structure leading to concepts to be induced throughout the entire program:

LITERATURE—BASIC CONCEPTS

ASSUMPTIONS FOR USE IN DESIGNING OUR CURRICULUM

A Definition of Literature	Literature is defined as a re-creation in a verbal art-form of what it has been like to be alive.
The Writer	The writer of literature is a person with a more than common desire to articulate his conception of what it has been like to be alive. Insofar as he is an artist, he is concerned with recreating his conception of this in a verbal art-form.
The Art-Form Conceived	What the writer produces consequently arises out of the interaction of: 1. universal perceptions and dreams common to almost all men everywhere

2. modification of these universal elements by his own life and by the culture patterns in which he lives
3. the literary form he chooses

The Art-Form Produced

Insofar as the writer is successful in producing literature, then, he has represented:

1. universal concerns of men
2. which are modified by environmental conditions (including his own personality)
3. and which are re-created in a verbal art-form

The Art-Form Perceived

Our study of literature therefore will be concerned with perceiving:

1. what universal concern of men the literature is dealing with
2. how it is modified by the environmental conditions of its place and time of origin
3. the nature of the verbal art-form in which it attains its being

In each year of the program, this basic framework will structure the literature program.

In a speech at the National Council of Teachers of English, Robert Slack, of the Carnegie Technology Curriculum Study Center, described how these concepts are evolved in the literature program on the tenth-grade level.

> When we came to designing the tenth-grade literature program, then, we structured it into six major units that reflect universal concerns of man.
>
> The first, and one of the longest, of the units we call "Social Concerns." In it we study literature which reflects man's concern with the society or environment in which he lives. We read, for instance, Ibsen's *An Enemy of the People*, Abraham's "Tell Freedom," Remarque's *All Quiet on the Western Front*, Dickens' *Tale of Two Cities*. Yes, Dickens, in the World Literature course—Dickens and Shakespeare, we decided, do belong to the world. And this novel, which so vividly evokes the French Revolution, seemed deserving of retaining its place in the tenth-grade course.
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"Our Lady's Juggler," to the idealized romanticism of *Cyrano de Bergerac*. We had some time, I will confess, finding in world literature a long fictional love story that we felt comfortable about teaching in a public high school. We finally settled on Prosper Merimee's *Carmen*.

The third unit is short, but a fascinating one, which we have called "Reality and Illusion." The literature deals with illusion, fantasy, and the supernatural. The chief work in the unit, which concludes the first semester, is Selma Lagerlof's delightful *The General's Ring*. We are sure the students will like this unit.

I wish there were time to give you more details about the second half of the year. Briefly, the three units are: "Heroism," in which we read some of the great epic stories, including I. A. Richard's version of *The Iliad* as well as Shakespeare's *Caesar;* "Human Weakness," in which we include Moliere's *The Miser*, and some stories by Maupassant and Tolstoy. The last unit is the most thoughtful, and we have called it "The Search for Wisdom." In it we include Schweitzer's *Memoirs of Early Youth;* Saint-Exupery's *Wind, Sand, and Stars*, a few of the Parables, and Plato's account of the death of Socrates.

The thematic approach to literature, by the very nature of what that approach is, evokes a perceptive analysis of the theme as it relates to the literature or of the literature as it relates to the theme. If, through proper questioning, a teacher allows the growth of this kind of discussion, students will gradually perceive the depth, the underlying structure of the literary work of art. These questions on an assignment from *The Tale of Two Cities* reveal the inductive method as it evolves out of a thematic approach. The theme, in this case, is called Social Patterns.

A. *Discussion Questions*

1. Why does Darnay speak to Dr. Manette before he speaks to Lucie?
2. Is there a possible forewarning in the second promise of Darnay to Dr. Manette?
3. What does Dickens show about Stryver when he decides to marry Lucie?
4. What does Dickens show about Stryver when he decides not to marry Lucie?

5. What is revealed in Carton's pathetic statement, "All my life might have been . . ."? Is his attitude toward Lucie included here?
6. How is Lucie's response characteristic of her?
7. Read parts of Chapter 14 for verbal humor.
8. Who is the honest tradesman? What is a Resurrection Man?
9. How does young Jerry get around his father?

B. *Points of Major Emphasis*

1. Dickens' humor: the characters
2. The developing character of Sydney Carton

In all of the Curriculum Study Centers, the inductive method of teaching composition is apparent because each center suggests ways for students to evolve principles of writing rather than to have those principles presented as an arbitrary list by the teacher. In addition, at Northwestern, where the interest is primarily in the teaching of composition, the Curriculum Study Center personnel are attempting to see the relationships between oral and written composition. Students, on all levels, seem to communicate much more effectively when they do so orally. Perhaps written communication may be improved by inducing principles from certain aspects of oral communication especially in the elementary grades.

Working from the research of the structural linguists, each of the Curriculum Study Centers, interested in language, is approaching the teaching of language inductively. Here in this lesson from Nebraska, we can see the inductive method of describing language at work. As the plan states, the purpose here is to allow the class to develop its own set of structural criteria.

USING STRUCTURAL CLUES TO CLASSIFY WORDS

I. On the blackboard: Hodgely the snikest burks grinked. The burks sorked the brids and magled the skards. The borkest glors slinkly dreeked the cloots. The glors wickled the cartest slanks goorly. The glors bloked the borest snarks.

II. To the teacher: Practice reading this paragraph of nonsense words aloud, so that you may read it aloud to the class. Give the student only a hint of a method for classification. The purpose here is to allow the class to develop its own set of structural criteria. This exercise should allow the student to *explore* language.

III. To the class: The preceding passage is written in a nonsense language which uses the *structural signals* of English. Structural signals are such things as word endings and words which function to connect other words together. It would be possible to omit the nonsense words used here, and, retaining the structural signals, substitute ordinary English words to make an intelligible passage. Before we do that let's attempt a classification of the nonsense words. Such a classification might reveal the principles underlying the structure of the English language.

1. How many different kinds of words can you distinguish?
2. There are 20 nonsense words; include each nonsense word in a group.
3. Do any two nonsense words have any one characteristic?
4. Are these two related to any other nonsense word?
5. Can you find yet another nonsense word which has this characteristic?
6. Group the words together in as few or as many groups as you like, but all the words in one group must have one characteristic in common; some may have more than that.
7. Do not try to give meanings to the nonsense words. This exercise has nothing to do with any meanings of these words.
8. Put every nonsense word into some group.
9. You are the linguist, exploring your language, observing your language and describing your language.

IV. To the teacher: The above questions are designed to help the students make their first observations and descriptions. The classification:

I	II	III	IV
burks	grinked	snikest	hodgely
brids	sorked	borkest	slinkly
skards	magled	cartest	goorly
glors	dreeked	borest	
cloots	wickled		
slanks	bloked		
snarks			

V. To the students: Now that we have made a tentative classification on the basis of word endings, let's see if the words in a particular group have anything else in common.

1. Do any words consistently appear with words ending in -s?
2. Do these words appear in a particular pattern with other words? (They appear before the -ed words)
3. Do snikest, borkest, cartest and borest appear in a pattern with other words? (After the and before the -s words)

In describing their program for the culturally deprived child, Hunter College has this to say in its plan for the inductive teaching of language.

> A linguistic approach to reading is also being used in developing materials. This approach will build on the speech patterns of these children and seek ways to bridge differences in their oral language patterns in the classroom. Some of the materials developed in methods of teaching English as a second language will be studied to determine their applicability to meeting speech and language problems of these children.

In the plans and work of the Curriculum Study Centers, we also notice the interest and working out of cumulative programs in the language arts. As one of its aims, Oregon says "that it will try to clarify the proper aims and content of the English curriculum in the junior and senior high school," and "with help from current research in learning theory and human growth and development, it will endeavor to produce a sequential English curriculum for these grades." In describing new curricular materials, Oregon emphasizes a detailed outline for a sequential curriculum in literature, language, and written and oral composition. Turning to Nebraska we find that the entire curriculum is based upon a carefully defined sequential order in all aspects of the language arts. In language, for example, the lessons move from simple games with phonemic symbols in the elementary grades to such complexities as the historical evolution of the sound of language in grade nine or the sound system of Shakespeare's English in grade twelve. Literature is planned in terms of units that span the entire twelve years of English education; these units have an underlying structure, an underlying literary aspect, but they differ in complexity and they build on one another. With the myth, for example, Nebraska begins the simple approach to the classical myth in grade three, continues with the Norse myth in grade six, on through the Indian myth, the Hebrew religious narrative, and Beowulf until by grade twelve, students may have a real comprehension of the essence of a play like *Oedipus* or *Dr. Faustus*. At Northwestern we find this same kind of emphasis on the cumulative approach to composition in such questions as, "Is there any desirable sequence among several kinds of character sketches?"

For an even more detailed account of an approach to cumulative teaching and learning in the language arts, we might turn again to a part of Robert Slack's speech at the National Council of Teachers of English in Miami:

> We feel that, in the three years, the course should be concerned with three major aspects of literature:
>
> (1st) the universal concerns of man that the literature is dealing with;
> (2nd) how the literature (or the concern) is modified by the environmental conditions of its time and place of origin; and
> (3rd) the nature of the verbal art-form in which the literature appears.
>
> In the World Literature read in the tenth grade the major emphasis will be on the universal concerns of man as these appear in various environments. In the American Literature program of the eleventh grade the major emphasis will be on how literature reflects (or indeed has helped to shape) the developing culture pattern of a single nation. In the English Literature program of the twelfth grade the major emphasis will be placed on a much closer analysis of the verbal art-forms in which the literature appears. Thus we plan to move from broad, elementary characteristics of literature such as theme and characterization and setting—which can and do survive translation from another language; we are moving *to* a close consideration of the richest textural works of art that appear in the students' native language.
>
> One determination we made very quickly. The literature for the tenth-grade would be World Literature. This allows the student to make many tie-ins with the World Culture course that he is taking in the tenth-grade social sciences program. Let me say at once that we have not in any way shaped the World Literature course in accordance with the pattern of the World Cultures course; English has its own needs, as social science has.

But it is obvious that some resonance between the two courses is sure to be set up in the tenth-grade student's experience.

For the eleventh and twelfth grade we decided to use the almost nation-wide pattern of American and English literatures—but to use them with a difference. The use of these two bodies of literature has the enormous practical advantage that English teachers of the eleventh and twelfth grades are already prepared to teach them. Furthermore the rationale we developed for the three-year literature program is very well served by this order.

Here we can see a logical movement toward a mature understanding and comprehension of the verbal art-form. Using the concepts that the experimenters have defined as important in the underlying structure of what literature is, they begin with the most simple, the universals, then build to a closer consideration of the text, to literature seen as an organic whole.

The cumulative approach to the language arts curriculum is an important aspect of the revolution in English teaching. Closely related to this approach is the attitude that the discipline called English combines the interrelationship of literature, language and communication, an integration that is noticeably apparent in the plans of the Curriculum Study Centers. In writing about their center, Oregon states:

> The center is assuming also that the skills will be more efficiently learned and the subject matter more readily understood and assimilated if instruction in both is closely coordinated. That is, although the subject matter is intrinsically valuable, worth studying for the discipline that it enforces on the mind and for the knowledge that it makes available, it also contributes toward mastery of the skills themselves, through having obvious practical value, can help the student understand the subject matter more fully—for example, when composition assignments are based on literature being read.

Minnesota will be especially concerned with the ways in which language may be taught as a more integral part of the whole language arts program. Their proposal states,

> In addition, careful consideration must be given to the relationships of the planned program of instruction about language

> to instruction in reading, writing, speaking and listening. The extent to which such a program of instruction about language may alter basic instructional techniques in the communication skills is at present largely unknown but may well be highly important. For example, it is not known at present whether a "linguistic approach" to reading instruction will effect improvement in this skill. Nor is it known whether instruction in linguistics will effect improvements in students' abilities to write and speak more effectively. While some linguists entertain the hope that linguistics may well have a profound impact on effective learning of the communication skills, a far broader and more basic consideration than immediate utility is involved. How should a program of instruction about language alter the students' conceptions of those situations in which he finds himself constantly using language?

In attempting to solve some of the problems that go along with the teaching of composition, Northwestern, too, attempts to find better ways to correlate composition with literature and even more, with language. Nebraska is also working toward the interrelation of the three into one so that the perception of the one is enhanced by the organic wholeness of the three. Certainly, the following writing assignments from Nebraska's plan indicate a correlation of literature, language and composition:

CREATIVE WRITING

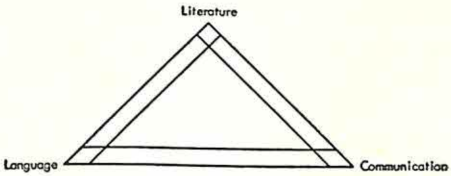
a. Pretend that you are an ancient Greek, and then introduce a myth (story within a story).
b. Write a transformation myth.
c. Poetry and the myth: the haiku could be written using figures of speech from myths. The poetically inclined could use other forms of poetry.
d. Write your own myth that is modern in style, material, and situation.
e. Write the conversation that might have gone on between Geres and Jupiter after Proserpina disappeared. Try writing dialogue and dramatizing other myths. Do not overdo this.
f. Write the conversation in which Phaethon asks permission to drive the chariot.

g. Keep a diary that Kiana might have kept.
h. Divide the Bulfinch myths into shorter paragraphs.
i. Create a situation in which a modern-day boy encounters a god.

Carnegie Tech indicates its intention to relate three aspects of the language arts with these rather interesting diagrams which symbolize the overall pattern of the program:

Basic Theory

The three areas of the program will be interrelated throughout.



Pattern of Emphasis

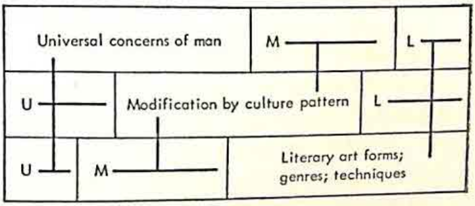
All basic concepts are dealt with in all years; only the amount of teaching time and the degree of emphasis change. For instance, in the 10th grade literature program, most teaching time will be spent on the universal concerns of man, less on modification by culture pattern, and still less on literary art forms. In the 12th grade, the emphasis will be reversed.

LITERATURE

10th Grade
World Literature

11th Grade
American Literature

12th Grade
English Literature

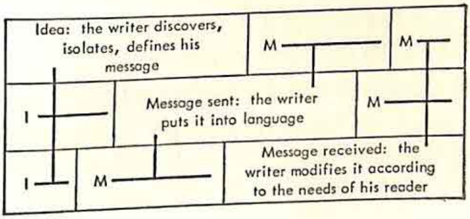

Universal concerns of man
M
L
U
Modification by culture pattern
L
U
M
Literary art forms; genres; techniques

COMMUNICATION

10th Grade

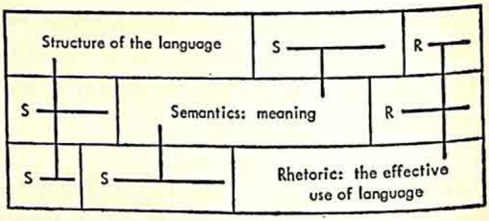
11th Grade

12th Grade


Idea: the writer discovers, isolates, defines his message
M
M
I
Message sent: the writer puts it into language
M
I
M
Message received: the writer modifies it according to the needs of his reader

LANGUAGE

10th Grade
11th Grade
12th Grade


Structure of the language
S
R
S
Semantics: meaning
R
S
S
Rhetoric: the effective use of language

Certainly what we have looked at so far in the Curriculum Study Centers seems quite specific; it is obvious that we have gone a great distance from the Basic Issues Conferences, not in idea, in concept, but certainly in realization—creation. Even more revealing of the extent to which the Curriculum Study Centers are contributing to the revolution in English is a close look at the extent to which they are accomplishing the five practical and workable possibilities that we mentioned before: Cooperation between schools and colleges, between subject matter and education people; in-service training for teachers in the field; specific and definite reforms in planned curriculum; improvements in teacher training on the undergraduate level and what we may call simply, time.

Each Curriculum Study Center is a cooperative effort. Oregon, for example, calls its center a cooperative undertaking:

> The center is designed as a cooperative undertaking in which junior and senior high school teachers and college professors of English and Education will work as equals, each person drawing on his specialized knowledge and experience so that the result of the center's work will have a validity that could not otherwise be achieved. Three contiguous school systems (Eugene, Springfield, Bethel) are contributing teachers to the work of the center and opening their classrooms to the experimental use of new curricular materials to be produced by the center. During the life of this project it is expected that there will be twelve junior high schools and six senior high schools, a sufficiently broad base for the experimental work that will be undertaken.

Northwestern has a center which is open to administrators, teacher groups, individual teachers, students—to anyone who is interested in the teaching of English and in a specific problem. It also plans to make affiliations with one junior high school faculty and one rather complex school system—all for the purposes of exploring more possibilities in the teaching of composition. Carnegie Tech, too, is working with many different school systems as Nebraska is also.

Minnesota also plans for interdisciplinary cooperation and also cooperation with the schools. Directors of these projects are from English, speech and education. In addition, personnel from sixteen departments are involved. The directors also state how language problems will be studied:

> *General Method* Information and concepts about the English language will be identified and analyzed in an interdisciplinary workshop involving scholars from English, speech, and education. With the aid of scholars from other disciplines and appropriate consultants, the information and concepts will be placed in six categories already identified. Through a cooperative project involving experienced secondary school teachers, a series of curricular materials and study guides will be developed for pilot use in selected schools in grades 7 through 12.
>
> Materials and study guides will be reviewed by appropriate consultants from diverse academic disciplines, both on this campus and elsewhere. Preliminary revision will be made on the basis of these critical reviews.

And in this program, they will use the Minneapolis schools. Minnesota also notes that a "Project English Invitational Conference" was held in December to acquaint leaders in the state with the Project English Program. Hunter College also plans to work with the schools, in this case, with the very difficult problems of the New York City school system.

All of the centers plan for summer in-service training of teachers who are in the field, and in each case, the in-service training combines with the creating of new curriculum materials. Oregon will spend its summer working with approximately thirty teachers from grades nine through twelve who will receive special training in summer institutes to familiarize them with experimental curricular materials and the fields of knowledge on which they are based. In addition, these teachers will not only help to create materials, but they will also revise and test them in actual school situations the following year. Similarly, many of the Nebraska materials have been created by combined groups of scholars, English teachers and education specialists in in-service training groups, and these materials, too, are being tested by the teachers. At Carnegie Tech, in-service training and curriculum planning were also combined in the summer program when four subject-matter specialists (Carnegie Tech faculty) and twelve high-school teachers both planned the three-year sequential program and also made definite plans for the tenth-grade experimental program now being taught in six schools by those same teachers and by two Carnegie Tech faculty members. Minnesota plans for language in-service institutes for teachers on all grade levels, elementary, secondary and college, and Hunter has this to say about the need for institutes of those who teach in culturally deprived areas:

> In addition, teachers assigned to schools in depressed urban areas are predominantly middle class. Moreover, they are often inexperienced, newly appointed teachers. They need and presumably will welcome new curriculum materials and guides appropriate to the needs and interests of their pupils. The Hunter College Center hopes to help provide such materials and guides for teachers to use.

Hunter also speaks about the specific materials that it feels need to be developed.

> *Meeting needs of English teachers* in junior high schools located in deprived urban areas is an important concern of the Hunter College Curriculum Center *Project English*. In the interest of developing curriculum materials and teaching guides for English teachers, the Center is considering procedures such as the following:
>
> Paired kinescopes showing reading lessons in junior high school grades to provide possible models for teachers in "special service" schools and to illustrate adaptations *and* similarities in reading instruction in different milieus.
>
> Annotated resource materials including lesson plans, reading exercises, films, records, with specific suggestions for adaptations to culturally underprivileged classes.
>
> Development of a collection of specific suggestions for relating speaking, listening, viewing activities with reading: e.g.,

oral directions for field trips, games, model construction, etc., accompanied by printed directions, printed fill-in forms to be used in "reporting" on trips, exhibits, sports events and the like.

Booklists for junior high school teachers annotated not only as to reading level and boy or girl "subject," but also as to cultural milieu, story pattern and role models provided.

Development of model 10–15 minute tests of reading comprehension based on reading texts and commonly used books and of directions for constructing such teacher made tests.

Bibliographies for teachers on theory and research in psychology, sociology, linguistics, and other fields relevant to the teaching of English to lower class urban children.

The specific facts relating to changes in programs for undergraduates who plan to teach English are, as yet, less definable than the other three criteria. These changes—this part of the realization from concept to reality in the revolution—must, of necessity come more slowly. One thing is unquestionably true. As college people—both scholars and education people—become more involved with in-service training, with the problems of the schools and with specific planning of curriculum materials, they will become more aware of the needs of their undergraduates in the English teaching program. At Carnegie Tech, we may discover a few rather specific and interesting by-products to undergraduates that have resulted from the Curriculum Study Center. Most important is the inclusion of some English teaching majors in the summer planning sessions. Questions to these girls, some of whom are now teaching, reveal that they found the experience invaluable in their first year of teaching. Questions to evaluating administrators reveal a similar satisfaction. More subtle perhaps, but equally important, are the small but significant changes in the undergraduate program. One change follows a redefinition of the future English teacher's needs in the study of language; and Erwin Steinberg who teaches The Nature and Function of Language indicates that he has reconsidered these needs in his course. Beekman Cottrell, Associate Professor of English at Carnegie Tech, who now teaches one of the experimental sections of the curricula, admits that his high-school experience has changed some of his ideas about the way in which he teaches his comparative literature course to English majors who will soon be teaching in the high schools. Realizing the importance of the inductive method, he attempts to use it more in his college literature course. In this direction, the reports are still vague; however, it must be said and believed that as colleges begin to understand the needs of the English teacher, they will slowly change their programs to fit those needs.

It is also interesting, in this same respect, to see what Hunter College has to say about their program in terms of providing new and adequate teachers for culturally deprived children.

> The Board of Education and Hunter College have been cooperating in a teacher education program for several years in a limited number of junior high schools in depressed areas in New York City. Student teachers volunteer for these schools and a college supervisor is given additional time to help them become acquainted with the life and traditions of the community. In cooperation with the school principal, student teachers are given various opportunities to observe the neighborhoods of the children they teach. Under agreement with the principal and the Board of Education, students who choose to do their student teaching in these special schools are given the assurance of employment in the same schools.
>
> Since 1960 when this cooperative program was introduced, more than 80% of the young teachers have chosen to remain in the special schools. The additional attention and assistance given to them is greatly valued, and they report that teaching in these schools is a challenging adventure which they want to continue.
>
> Hunter College hopes this cooperation with the Board of Education will continue and also that through *Project English* new channels for cooperation can be opened to provide and utilize promising materials in reading.

It is perhaps foolish to mention the significance of time; that significance is so obvious, and time is so illusory. But we must always remember that without time—and time also implies means—even the best plans must fail. Colleges must have time to release faculty for in-service training institutes and curriculum planning. Schools must have time to plan and test the results of these. In short, progress from the concept to the creation on all levels, demands time. What the Office of Education is actually doing is not itself writing curriculum but giving to the academic world and the educational community the time to create and then effect a revolution.

Beyond Project English

This revolution for English is taking place with no less dramatic force in other areas of the curriculum as well. And even in those subjects where no self-induced revolution seems apparent, the climate of change, the feeling for experimentation and the challenge for excellence produced by the new educational technology already leads to ferment. In each of these areas, the Office of Education in collaboration with other federal agencies such as the National Science Foundation will continue the support of research and the development and demonstration of the new curricula. In each area the Office will also continue to look to the university scholar, the researcher, the teacher and the administrator to take the lead in producing curricular innovations.

While the Office is interested in proposals for curricular development in any area and at any grade level, the identification of particular subject areas for special attention will continue for some time. In fiscal year 1963, the new area for special emphasis is the social studies. As in Project English, the purpose of Project Social Studies is to improve at all levels of education the teaching of the variety of courses generally called the social studies. Unlike Project English, the curriculum program of the Office of Education is only one of several now under way.

Although one of the most recent subject areas to undergo national effort for improvement, the growing awareness of the importance of social science content at all levels of education has made curriculum revision in the social studies a primary goal of a number of groups. In addition to Project Social Studies of the U.S. Office, some of the more important current efforts to revise the social studies program are:

(1) The Social Science Course Content Program of the National Science Foundation

(2) The joint efforts of the American Council of Learned Societies and the National Council for the Social Studies

(3) The developing social studies program of Educational Services Incorporated

(4) The individual efforts of local groups such as the Educational Research Council of Greater Cleveland

(5) The several task forces at work on specific aspects of the social studies program; e.g. The American Anthropological Association; The American Economic Association; The American Association of Geographers; The American Sociological Association; several other associations and groups in various degrees of involvement.

Such attempts at curricular revision in the social studies are not new. As early as 1897 the "Committee of Seven" of the American Historical Association made a series of recommendations centering around the importance of "history for the sake of history."[25] This report did not go unnoticed. In 1916 a committee of the National Education Association challenged these recommendations as being based upon the naive assumption that all students would complete high school and thus receive the full series of courses recommended by the "Committee of Seven."[26] These assumptions were not so, argued N.E.A.; many students did not finish high school and so there should be two cycles in the social studies: geography, civics, European history and American history for grades seven through nine, and European history, American history and a new course "Problems of Democracy" for grades ten through twelve. This new "problems" course was to draw materials from the broad range of the social sciences, particularly economics, government, and sociology. This report marked the movement into "social studies" as a unified (if confused) subject and began the growing drift away from the disciplines.

By 1929, the course of educational change had even permeated the American Historical Association and its Commission on the Social Studies moved perceptibly closer to the N.E.A. position of 1916. In a series of seventeen volumes published between 1932 and

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[25] *Ibid.*

[26] National Education Association, *The Social Studies in Secondary Education* (Washington, 1916).

1942, the Commission posed two major objectives for the social studies: the creation of socially sound personalities in children and the goal of a model society based upon the best available social science knowledge.[27] And there they left it. Few if any practical suggestions emerged; certainly no materials of use to the schools were produced and any concept of scope and sequence was nowhere to be found. If anything this report only tended to widen the gulf between scholar and schoolman.

Then in 1939 the National Council for the Social Studies brought out its volume on the future of the social studies with a variety of proposals for structuring the school social studies offerings.[28] If the historians had erred in 1929 in failing to consider scope and sequence, the report of the National Council certainly did not make this omission; but it was criticized for lack of substantial social science content. Again in 1956, the National Council released the preliminary report of its committee organized to identify the concepts and values for use in the social studies.[29] After identifying twelve general themes or goals implying concepts and values to be taught, the report went on to suggest that specific adaptations of its general programs should be developed on a regional or local level.

From this point on the history of the social studies is characterized by almost constant criticism from various groups of university scholars that the social studies represents a melange of watered down social science. While many social studies specialists agree, they are equally quick to point out that the scholar has done little to assist in developing materials and where he has done so, he usually hasn't done so with any concern for what really goes on in the schools. Thus today, while there are several groups of discipline scholars and social studies specialists working jointly (and well) on new materials, the rift between the disciplines and the social studies continues.

Today this dispute has taken on somewhat new characteristics. While the manifest expression of needed rapprochement between scholar and schoolman continues to grow there is still latent disagreement on such questions as what types of materials should be produced, what should be the role of the social scientists, and the need for a whole-learning approach to the social studies with proper attention to scope and sequence.

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[27] *Report of the Committee on the Social Studies of the American Historical Association*, 17 v, New York, 1932–1942.

[28] *The Future of the Social Studies*, National Council for the Social Studies, Washington, 1939.

[29] S. P. McCutchen, "A Guide to Content in the Social Studies," *Social Education*, XX, 5, May, 1956, 211–215.

The university scholars, both the social scientists and others who have recently developed an interest in the social studies, look at present courses and usually come up with the criticism that they are based upon outmoded techniques and concepts. Scholars and learning theorists, for example, question the common rubric for forging together the diverse materials in the social studies program. Usually a set of materials is produced stemming in the main from an "expanding community" theoretical framework. Based upon some now questionable research of the early thirties, this approach assumes that the child is presented to the schools as an egocentric organism and only gradually, with the help of his teachers, develops concern for people and places about him. Thus he learns first about his family, then his neighborhood, then his community, then his nation and then the world.[30] Many of the critics of this approach point out that the child's introduction into the world of television, for example, has drastically changed the validity of this sequence. Others question it from the point of view of the social scientist who is troubled by the problem of how to introduce objective social science data and concepts into this value-oriented social studies. Many social scientists question the continuation of the social studies and are suggesting discipline courses for the schools—a high school sociology course, a high school anthropology course, an elementary school economics course and so on. Other social scientists feel the need for continuing the social studies but would do away with the "expanding community" and substitute a program based upon social science concepts rather than the attempt to fit the concepts (or have someone else fit them) into an existing course.

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[30] Dorothy McClure Fraser, "The Organization of the Elementary-School Social-Studies Curriculum," in *Social Studies in the Elementary School*, 56th Yearbook of the National Society for the Study of Education, Part II, 1955, pp. 131–153; John U. Michaelis, *Social Studies in Elementary Schools*, 32nd NEA Yearbook, National Council for the Social Studies, pp. 112–113; John Jarolimek, *Social Studies in Elementary Education* (New York: The Macmillan Company, 1959), pp. 52–69.

The social studies specialist is not unaware of these movements and often views them as belated and educationally unsophisticated expressions of concern by a group whose field of knowledge (and real interest) is at the university rather than school level. "What," they ask "are the scholars going to do about fitting their view discipline courses into the already crowded program?" "Who," they ask, "is going to teach those new courses?" And to these questions they usually add the major one: "What is to happen to the overall structure of the social studies?"

It is within this context of disputation among several quite different groups already under way that Project Social Studies got under way in October of 1962. To date several activities have taken place and others are about to start or are planned for the future.

Funds are presently and will continue to be available for basic and applied research related to the social studies and social sciences, for developmental activities such as conferences and seminars, for curriculum development programs and, at a later time, for demonstration of new material on techniques in the social studies. Several projects are now under way including a developmental contract with the Massachusetts Institute of Technology to work with the Educational Services Incorporated social sciences group in the development of a concept oriented social science curricula. In addition, a conference on needed research in the social studies is planned for early spring to bring together scholars from the disciplines, researchers, social studies specialists and school people, for a common look at the field.

The major effort in Project Social Studies as in Project English, however, will be in the area of curriculum development. Early in 1963, thirty-three applications for Curriculum Study Centers were considered and three selected for immediate financing. Another ten of these applicants were asked to resubmit their proposals for consideration early in the Spring of 1963. The centers selected were at Carnegie Institute of Technology, Harvard University and the University of Minnesota.

The Curriculum Study Center at Carnegie Institute of Technology aims at the development of a sequential and cumulative program in history and the social sciences for able students in grades nine through twelve. As in the English center at the same institution, the emphasis will be on the development of materials for an inductive approach to teaching history and social science. Throughout the entire sequence of courses the staff will stress the modes of inquiry of the social scientist and the historian. Thus the scientific approach to human behavior from the social sciences and the process of interpretation in history will be used to structure their inductive approach. Again as in the English center, various aspects of critical thinking will be used and an important focus will be on teaching the structure of the social sciences. The concept within the structure of the subject thus again emerges as the central unit of learning.

During the summer of 1963, teams of university scholars and high school teachers working together will develop new materials to be tried in five Pittsburgh high schools. The materials will be used by twenty classes taught by teachers trained in their use and the two project directors, both university social scientists, will each teach one class a year in the high schools. There will be almost constant and immediate revision of materials as they are tested in actual teaching situations.

The Harvard center proposes to develop an integrated social science program for grades eight, nine and ten focusing on the analysis of controversial public issues drawn from jurisprudence as well as social science. Present plans for this center describe three distinct but closely related objectives. The first objective calls for the development and evaluation of a curriculum which will include about thirty teaching units organized around five persistent societal problems:

(1) the problem of keeping individual and societal conflict within tolerable and reasonable limits;

(2) the problem of maintaining a reasonable balance between individual liberty and community cohesion;

(3) the problem of maintaining or developing a just priority of privileges among men within society and among nations;

(4) the problem of providing a standard of living for all men sufficient to maintain a "civilized" existence;

(5) the problem of determining the range of behavior necessary for men to express reasonable dissent in their efforts to effect social change.

Each problem will be treated several times in the context of increasingly complex situations and will require constant reinterpretation as new ethical, legal, analytic and social science concepts are introduced. The curriculum materials will also include a descriptive guide to a set of suggested concepts and generalizations to be drawn from a series of case materials by using inductive teaching techniques. The following sample illustrates relationships among problems, cases and concepts.

PROBLEM: THE CONTROL OF VIOLENCE

In order to introduce the problem and to dramatize the fact that violence control can be thought of as a problem, a brief emotional impact lesson might be staged. This could consist of descriptions of atomic explosions, perhaps pictures of Hiroshima after the blast; photographs, films, or descriptions of a lynch-crowd or other similar mob action; perhaps a description of the breakdown of social controls during great natural disasters.

FIRST ROUND

Topic A: The Family

This topic would present a fairly simple introduction to the problem. By what means is violence controlled within the family? Probably, we would draw on personal statements, hypothetical cases, and some clinical documents. The Cain and Abel story might be good.

The basic concept would be *restraint:*[31] external restraint of parental authority; internal restraint of conscience; love, fear, and regret as motivations.

Topic B: The Peer Group

What are the limits on violence within the students' peer groups? We would start by focusing on personal experience, as above. In order to broaden the context, assuming that the students with whom we worked were by and large non-violent middle class, we may use situations in which there is more tolerance for intragroup violence. This could include the use of violence as a ritual means of acceptance and of settling disputes—violence as a part of the rules of the game. Excerpts from *Lord of the Flies* might provide good material.

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[31] Distinctions among general analytic concepts, legal and ethical concepts, social science concepts, etc., are not made here, as this is only a preliminary draft. Also it is hoped that the interaction among these concepts in the proposed curriculum will be emphasized.

Concepts: the inadequacy, in this context, of the restraints of internal regret or external superior authority which are operative in the family. Introduce *rules of the game*—small-group laws and sanctions. This might lead to questions of how rules are arrived at, when they are applied, and who directs each of these forces. The discussion might then move to *social role, function,* and *structure;* also the question of why does one go along with rules, i.e., *motive. Shared values* would also be important. It must be remembered that these concepts will be presented in very simple form to begin with. In each following topic, for this and other problems, concepts introduced earlier will be repeated and developed.

Topic C: Primitive Cultures

What kinds of different norm systems exist in a variety of primitive societies in order to control violence? Cases could be based on the "Ways of Mankind" recordings which present a wide range of primitive conceptions of law.

Concepts: law as rules of the game in a larger society than the peer group; *culture; institution; rights; power; authority; legitimacy; control; adjudication.* Definitional concepts of *vagueness,* and *ambiguity:* What constitutes violence?

Topic D: American Communities

What kinds of value-systems and legal-social controls exist to control violence in American communities? This topic would aim to develop the relationship between law and social order in specific situations relatively familiar to the students. Cases might be: a typical middle-class community, with minimum violence-control problems; Clinton, Tennessee, in 1957; Oxford, Mississippi, in 1962; labor violence in a Northern one-company town; Kentucky or West Virginia coal towns; Vigilantes in 19th Century California or Southwest.

Concepts: rule of law; consent; elaboration of prior sociological categories.

SECOND ROUND

The second round of the problem of violence control might be a study of the development of Western legal and political systems. The study would not be a detailed examination of political movements, theorists, and systems so much as a schematic history of the development of such concepts as the *social contract, rule of law, constitutionalism, personal* *freedoms* (speech, religion, association, press), *federalism, due process, social justice,* and the like.

THIRD ROUND

The third round would focus on the question of what happens when there is a breakdown of law and social order within societies leading to redefinition of law and the terms of social order. Possible cases here would be, in order of ascending complexity: the American Revolution or Civil War; the French Revolution; the Russian Revolution.

As materials are developed, the Center staff will also explore research methods for reliably describing central constructs which might relate to the adolescent's conceptualization of personal problems to his view of social and political problems. These data will be used to modify and revise curricular materials. The third phase of the Center's plan of operation involves the further development of a system for content analysis of oral discussions based on controversial issues. The refinement of this technique would aid in the evaluation of the social studies program by allowing for more adequate criterion measures by which to assess the power of curricular materials and teaching procedures.

The University of Minnesota will prepare and evaluate curriculum guides and sample pupil materials for social studies in grades from kindergarten through junior college. Once again the importance of the structure of the subject and the key concepts are central issues in the proposal for this Center.

At Minnesota, a team of scholars from the social sciences and education will define the structure of each discipline in terms of the field studied, the methodology and perspectives by which scholars expound knowledge in the field, and the key concepts and conceptual framework in the discipline. After identifying areas of similarity in concepts and methods as well as differences, the staff of the Center will attempt to establish a curricular structure within which to develop teacher guides and resource units.

An important characteristic of the Minnesota Center is its orientation toward existing research studies, particularly the work in cognition by Bruner and his associates. The approach at Minnesota is that while much recent research evidence indicates quite clearly that young children possess the ability to conceptualize complex social science data, other research shows just as clearly that children in grades one to three do not have the school experiences which will permit them to do so. The findings from these studies imply that teachers fail to capitalize fully upon pupils' abilities to conceptualize and that school programs may be improved by giving increased attention to newer techniques of concept formation.

As materials are developed, they will be tried out in the university schools and in selected public schools, and the results will be used in revising the materials. Teachers will be trained to use the materials for both this tryout and for later evaluation stages in summer institutes conducted by an interdisciplinary staff of educators and social scientists. At the completion of the five-year program, the materials themselves will be made available to schools throughout the country.

The aims and methods of the three social studies centers are thus somewhat divergent. But all obviously feel that somehow an inductive cumulative and interrelated program in the social studies must be prepared for the schools. Although they differ somewhat on the "somehow," the basic approach is the same, and not very different from most of the centers in English. All point to the importance of concepts, each stresses the inductive method and all seek to find the structure or framework—the "great and simple structuring ideas" —in which to fit the concepts. These centers and the several others to be selected later in 1963, will provide a source for curricular materials at any and all grade levels for adoption by schools. Along with the English centers and those which will be established in other fields, they indicate what can be done by scholar and schoolman working jointly with government support.

Beyond Project Social Studies are plans for significant expansion in the Office's activities in curriculum research and development. This expansion will come both in areas of concern and in the scope and size of the programs. In 1964, for example, several new programmed areas will be added including a major effort to improve teaching in music and art. In the same year a curriculum revision program will be undertaken in teacher education. Hopefully, the approaches to curriculum revision which have won success in the schools will be equally successful in preparing materials for use in pre-service training of teachers. Finally, 1964 should also see the first ventures into the preparation of curricular materials for pupils with learning disorders—the blind, the deaf, the mentally retarded, the speech handicapped and others with learning problems. Our hopes in this area are based on the success of one Cooperative Research Program project which successfully increased the rate of learning in blind children from sixty to two hundred and forty words per minute by use of compressed speech recordings rather than Braille.

While these areas are singled out for special attention, all subjects in the curriculum and all grade levels are of concern to the Office. Proposals in any area will be considered either by the Office alone or as joint programs with other agencies such as the National Science Foundation. We need and will continue to need a variety of new approaches, new personnel and new interest in all areas of curriculum. Only when we have them will we be able to foresee the development of a rich, articulated, teachable curriculum program.

Some Future Possibilities

We have gone this far. What next? Unquestionably, there are still many shadows between the concept and the creation, for just as a shadow can only take form from the object which it represents so the Curriculum Study Center can affect only those institutions within its reach. Realistically, that reach extends only to the educational community which is directly involved; therefore we must ask "what next" in terms of how to diffuse the new innovations in education throughout the schools. Diffusion, however, involves two things; there must be something of value to be diffused and there must be some mechanism through which diffusion may take place.

If in the Curriculum Study Centers we have been able to involve as partners, scholars, teachers and administrators, and if we have been able to develop small blocks of good curricula, then, indeed, would it not be possible and desirable to do so on a larger level. We think it would be possible. In fact, we feel it is essential if curriculum revision is to have any lasting effect on the schools.

The first step, then, would seem to be the expansion of the present Curriculum Study Center concept in terms of both the curriculum materials developed and of the scope of their activities.

Our experience so far has given clear indications of the need for more articulated, wider ranging curriculum revision programs. Thus, while it should always be possible to develop special materials for a grade ten to twelve English program for the college bound, the greater present need would seem to be to provide some comprehensive means for designing a total English curriculum from kindergarten through college years. The immensity of this task makes the "two hundred and fifty thousand dollars for five years" limitation of the Office's contribution to each center seem unrealistic. Future curriculum revision programs of the Office of Education will consequently do away with financial limitations both as minima and maxima.

The need for a higher level of financing, however, is only one dimension of the new problems created by expending which would be the curriculum study centers. No university can be expected to have available the range of expertise necessary for producing a major curriculum development program. In addition to first-rate subject matter scholars, the university must provide, or locate and obtain, equally competent writers, curriculum specialists and in many cases, new educational technicians, expert at sheer "gadgetry." Equally as important as the subject matter specialist is the classroom teacher; no curriculum revision program which ignored early involvement of teachers in designing and testing new curricula has ever been successful. Since the materials must eventually be used by teachers, a whole new group of individuals must be available to the Center; teacher-educators, specialists in school administration, test design specialists, and a host of other skills. If the university cannot supply the best of each of these skills, and we do not know of any university which can, they must be found and induced to leave established positions for the period of time their services are required. Then when the curriculum is produced and ready, someone must also be ready to train teachers in its use. What assurance is there that the teacher training facilities available to the Center are the proper ones and how does one export teacher training to other parts of the country? And what of the continuing education of teachers after leaving a "special summer course" or teacher institute? And what of the need for almost continuous revision of the curriculum materials, by whom, how and when will this be done? Perhaps the summary question should be: "What instrumentality exists to take as its complete responsibility the constant design, development and demonstration of new curricula?" Our answer to our own question is that such an instrument does not exist but is perfectly possible under present and proposed programs of the Office of Education.

The hub of the proposed new Office of Education Curriculum Research and Development Program would be the Curriculum Program Center and its associated demonstration schools established by university, group of universities and colleges, or some para-university enterprise in association with a State department of education. Each center would, with long-term Federal financing, conduct research, develop and test new curricula, establish demonstration and training programs and generally perform all of the functions now scattered among various institutions. Centers would be established in each of the major curriculum areas and would be associated with a nation-wide network of model demonstration schools where new curriculum materials developed at various centers would be tested, evaluated, and made available to local school systems. The following figure describes the relationships among two such centers, one in English (language arts) and one in the social studies, and associated demonstration schools, colleges and universities and school systems.

Each center and its demonstration schools would carry out the curriculum research and development now performed by the Curriculum Study Centers but would have other programs as well. The most important of these programs would be:

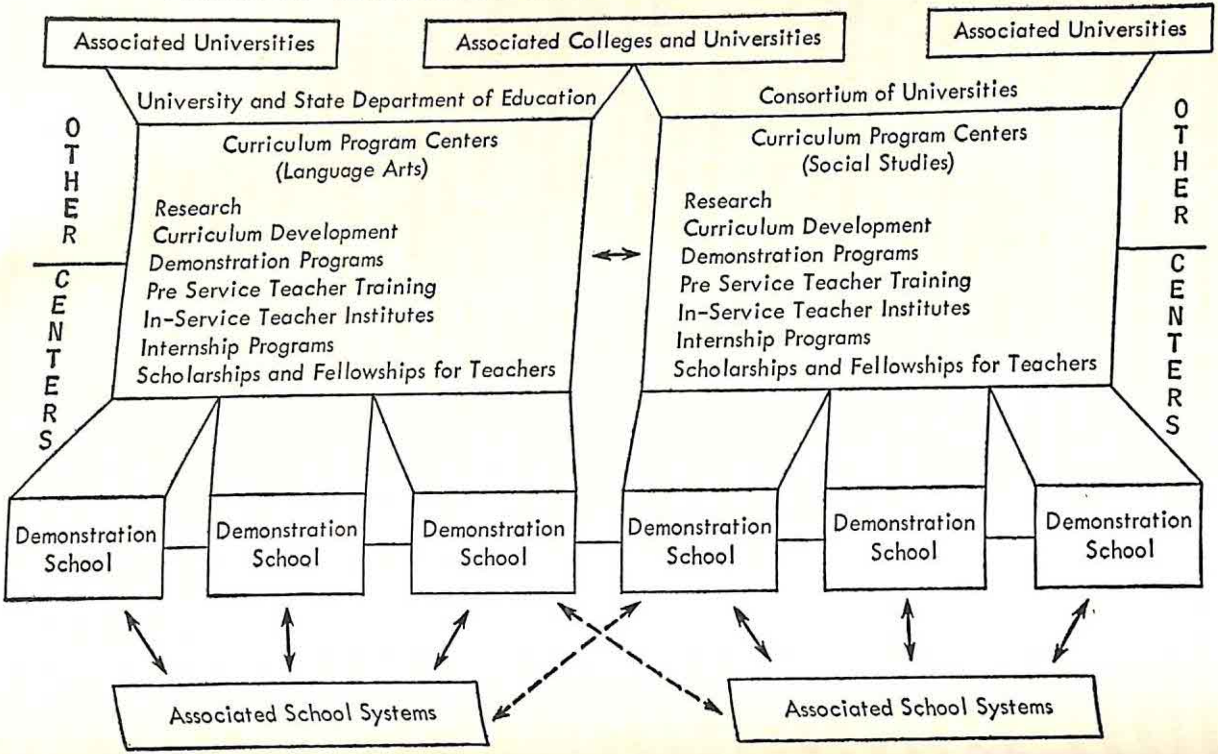
(1) Institutes for elementary, secondary and junior college teachers to increase their knowledge (of language and literature, for example) and to acquaint them with the new materials and with new teaching methods. As is presently true in science, summer, academic year and in-service institutes would be established as well as extension courses at other universities, colleges and school systems.

(2) In conjunction with associated universities and colleges, a pre-service training program would be developed with instruction in specific techniques for teaching the course materials developed at the Center.

(3) A scholarship and fellowship program to aid teachers in professional improvement which will be required for the new curricula.

(4) Special short seminars for college teachers to familiarize

PROPOSED CURRICULUM RESEARCH AND DEVELOPMENT PROGRAM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(Language Arts)
Research
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Demonstration Programs
Pre Service Teacher Training
In-Service Teacher Institutes
Internship Programs
Scholarships and Fellowships for Teachers
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Research
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them with research and to facilitate exchange of information, ideas and techniques.

(5) Arrangement for storage and retrieval of bibliographical information on research in teaching the subject covered by the Center and on the subject itself.

(6) Facilities for carrying out either at the Center or through one of the associated universities, programs of basic and applied research necessary to the development of the curriculum.

(7) Facilities for adapting the use of such innovations as programed instruction, television teaching, and learn teaching to the new curricula.

(8) Special programs would be developed for the study of slow and bright children, culturally deprived and culturally rich areas with a view toward the possible need of special content in special situations.

(9) An internship program which would bring individuals (such as school administrators) to the Center to develop a familiarity with the purposes and functioning of the Center and the implementation of the new curricula.

In the performance of these functions, the Center would draw on a large resident staff as well as specialists from the associated schools, colleges and State education agency. Some of the associated colleges, for example, might provide the pre-service training facilities under the guidance of the Center. Others might work on particular types of training programs such as preparing social work trained English teachers for slum schools. While each center would work in a particular curriculum area, there would be constant exchange of information and materials and even personnel. The model schools associated with each Center would also use and demonstrate materials from other Centers for essentially, this would be an association of Centers working on similar problems.

As you can see, we envision the curriculum Program Center as a new relationship rather than a "place" and as a continuous process rather than a series of somewhat related projects. Whether they will come into being is now not so much a question of intent as it is a question of timing. Certainly the Office of Education and more specifically the Cooperative Research Program has been moving in this direction in the last two years. Just as certainly, all of the elements of this scheme are now possible under existing authority. Now all that remains is to assure the more suspicious among educators that federal aid is not synonymous with federal control and that the time has come for bold, new steps in the improvement of education. Such steps will not come about without some positive articulation between the federal concern for excellence in education and the reality of new curricular revision programs.

And even this will not create the absolute reality. Perhaps in education there is no absolute, no final being since "the process of education" is a continuous becoming, a constant flux. To be even more specific, no curriculum can ever be in final form because as societies change so do the needs of both the individual and the society. The Aristotelean notion of change and reality and Bergson's observation that "we change without ceasing and . . . the state itself is nothing but change"[32] are peculiarly true of education today. Certainly, the reality of education is a changing process; therefore it is the role of the U.S. Office of Education to foster the demands of that reality as it exists in an ever moving and fluid society.

[32] Henri Bergson, *Creative Evolution* (New York: Vintage Books, Random House, Inc., 1944.) Translation by Arthur Mitchell.

11

New Approaches to College Preparatory English[1]

EDWIN H. SAUER · CHICAGO TEACHERS COLLEGE

For a person who has been deeply involved for the past seven years in the training of high school English teachers there is an immediate danger in commenting on the changing college preparatory curriculum. What one announces as changes or trends could so easily be only wishful thinking or the verbalization of what one greatly desires to see. There is, furthermore, the hope that the verbalization, done sufficiently often and in sufficiently high places, can actually start the changes in motion. Curriculum revision must begin somewhere, and the objectives which guide the revision are picked up, more often than not, from conferences and meetings where educators gather and ideas are exchanged.

And, indeed, much of the attempt to determine change in the English course of study at the present time is either guesswork or foretelling the future, or both. It is easy enough to comment on practices now in vogue which were not in operation 25 years ago. It is equally easy to point out the revaluation of old materials and procedures and to show that in the teaching of English—both in the content of the course of study and the methodology—there is a cyclic pattern. The new quickly becomes old, and suddenly the old is sparking with life again. But to try to say with honesty and authority what the future holds is not easy. The English course of study, great complex that it is, now finds itself peculiarly susceptible to history and accident. The teacher of English yields, perhaps even more frequently than his colleague in the social sciences, to the pressures of social and cultural determinism. Language—every language—is suddenly an instrument of military power. A current joke, not very funny, has it that the difference between an optimist and a pessimist is that the optimist has his children learning Russian and the pessimist has his children learning Chinese.

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[1] Previously titled "New Approach to English Emphasizes Better Writing." Reprinted by permission of the publishers and the author from *The Changing College Preparatory Curriculum* (The Ninth Colloquium on College Admissions of the College Entrance Examination Board). Copyright, 1962, by College Entrance Examination Board.

What the teacher of English will be doing a decade from now—in college preparatory or non-college-preparatory curriculums—may be determined by historical circumstance of which we cannot possibly take account. The safest procedure is to describe what good secondary schools are currently doing, in a guarded expectation that they will probably continue; and then go on most cautiously to prescribe a few revisions which seem appropriate to our present situation.

It will scarcely come as a surprise, even to people outside the profession of teaching English, that the principal new emphasis of recent years in the English course of study is composition. Much of the renewed activity dates from the publication of James B. Conant's *The American High School Today*, in which he asserts that 50 percent of the high school English program should be given to writing and that every high school student should write at least one theme a week.[2] But even before the Conant report, there was evidence of a growing distress about the inability of the American student to organize thought in prose paragraphs. To many, Dr. Conant's statement was the expression of strong convictions which they were already trying to put into practice. Remedial English courses in the colleges and universities had been increasing at so alarming a rate that college and high school teachers began sitting down together to seek solutions to the problem; and the solution that the college people favored was plainly that students should do much more writing, specifically much more writing of expository paragraphs. The development of the Advanced Placement Program gave additional impetus to composition, as did innumerable conferences, committees, and discussion groups in all parts of the country. The American student

[2] New York: McGraw-Hill Book Co., Inc., 1959, p. 50.

in high school is writing again. The theme a week is rather generally regarded as the desirable standard.

One is not sure, however, that the increased amount of writing is always producing the desired results. Teachers of English are discovering that just to write is not enough. The program in writing must grow, first of all, out of a philosophy of composition—that is, out of a coherent statement of what the high school composition program is for. The following assumptions about a writing program in the secondary school seem legitimate.

It looks beyond the mere writing exercise to see that the objectives have to do ultimately with the organization of thought. Work primarily in exposition and persuasion makes the student aware that throughout his life, and whatever his station, he will be called upon regularly to organize his thinking in clear logical patterns, and that writing exercises are an effective means of helping him to see the reciprocal relation between thinking and expression. This is not to insist on a narrow practicality in all writing exercises but only to help the student understand that the written expression of thought can be a means of learning both what he wants to say and the most expeditious and forceful means of saying it.

It is a program for *all* students; the orderly communication of thought is constantly demanded by modern life, even of people of limited intellectual enterprise. Furthermore, the composition program need not differ too greatly because of varying abilities in the students. Our expectations of the students will differ, but the assignments, though modified somewhat from class to class, can be the same for all; the majority will deal with the shaping of thought in ordered paragraphs. Thus the program will probably be organized around exercises in clarity, logical analysis, critical thinking, definition, elementary semantics, and principles of argumentation; but there is room also for purposeful narration and description.

It is a *writing* program, not a course in grammar or literature or linguistics—though elements of all three, as well as of other disciplines, might at times be functional in assisting the understanding of what good writing is.

It is a program that avoids concentration on composition error—that does something other than focus the teacher's activity on mechanical blunders and bad writing. Students should be made aware of the many varieties of good writing and, through analysis, helped to see the nature of the achievement. This is the positive approach to composition—a concentration on language success rather than failure. The negative approach, the other side of the coin, begins with the way in which the teacher's attention to a student's theme is described. We say that it is being "corrected," that is, made right. We start, in other words, with the conviction that it is faulty or full of errors. The teacher marks these errors precisely and then refers the student to an appropriate section of a handbook for a review of the "rules" governing his defections. Usually, also, the student is asked to correct a few exercise sentences filled with errors of the kind he is prone to, and then to hand in the corrected theme and the corrected exercise sentences. Everything is right now—composition has been taught. Nothing has been taught except how to do exercises in handbooks, a somewhat limited achievement.

The positive approach in composition looks at success in language everywhere and then helps students to emulate it. The effective teacher of writing on the high school level begins by showing students how accomplished they already are, how much their contemporaries and peers have been able to achieve, how the patterns of success for student writing are quite the same as those for the great prose styles of literature, and how the writing of good, clear prose is a constructive act that can be learned, with no mysteries or enigmas which limit the accomplishment to those who are easily inspired. When composition programs fail in schools where the students are able and eager, it is often because the teacher has a faulty notion of what good writing really is. The teacher confuses strength and vigor in a prose style with archaic literary elegance on the one hand or with the proprieties of middle class gentility on the other. The standards of achievement in the high school writing course should not be determined by the prose styles of either Walter Pater or Dale Carnegie.

It is a program which insists that adequate attention be given to evaluation of the papers. It resists an automatic manner of marking them—the employing merely of a mechanical set of symbols (*sp* for spelling, *p* for punctuation, *d* for diction, *cst* for faulty construction, *k* for awkward). The very differences in any set of student papers are sufficient indication that no automatic method of marking them can in any way help the authors and call attention to the individual difficulties. Whoever marks the papers must be directly personal and individually analytic. Marking must be a series of marginal questions constantly asking the student to re-examine what he has written, and occasionally writing for the student what the teacher's more informed sense of style would indicate that the student intended. The marking of the paper, beginning with appreciation of and comments on the successes of the paper, must then go on not to destructive and negative underscoring of all its errors and deficiencies but to a series of inquiries of the writer which will cause him, in revision, to *re-think* the paper and bring it to greater clarity and order.

It is a program with sequence and order. Composition cannot be an ad-lib or ad hoc activity. Assignments must be part of a carefully planned syllabus from grade 7 through grade 12, with one exercise leading sensibly to another different and gradually more difficult exercise. That the whole high school English program has never been able to achieve sequence is, without any doubt, its major failure. To correct the failure, we can begin with sequence in composition. Increasingly, one notices the formation of curriculum committees in our larger school systems which, with the aid of consultants from colleges and universities, are constructing sequential programs in composition. If the amount of writing now being done in the American high school continues to increase, as seems likely, and if it is done according to a careful plan over the student's whole secondary school experience, we can certainly expect in a few years a refreshingly new kind of literacy in our college freshmen.

Books on How to Write Lacking

A curious and distressing fact, however, is that the schools will have to work out these plans largely without prepared materials. There are virtually no composition books on the secondary level. There are grammars aplenty, and many of these are plenty bad. There is also the kind of book which attempts to be all things to all people and contains everything from the history of the English language to instructions on how to telephone the supermarket. But there are very few texts which apply themselves practically and rigidly to the hard business of learning to write, with exercises and assignments suggested to the teacher. Books of this kind are in preparation, by at least two of the major publishing houses. Within two or three years there should be available to teachers from grade 7 through grade 12 textbooks in composition which offer nothing less than a coherent course of study, including a handbook of grammatical reference and exercise books for additional writing practice. The appearance of these books may very well have a major effect on curriculum revision in English.

Sequence in composition will surely cause the planners of it to take a careful look at how writing has been traditionally taught, that is, at such matters as the kind of assignment, the length of paper, and the potential audience for it. Wholesale student disaffection in English has often been the result of students being asked to do downright silly things, and nowhere has the silliness been more apparent than in the theme topics they were asked to write on. These group into a variety of categories, but three are significant and persistent. There is, first of all, the theme of personal reminiscence: "An Interesting Vacation Experience I Once Had," or the one which brings out all the whimsy, *schmaltz*, and "corn" in the youngster, "The Most Unforgettable Person I Ever Met." Then there is the theme of social comment, which ranges in topic from the American Legion favorite, "What America Means to Me," to "What I Can Do To Improve the United Nations." Both provide the student with maximum opportunities for plagiarism. The third type, the favorite of the teacher who insists on giving to high school students the kind of literature instruction he had in college, is the topic of literary analysis: "The Symbolic Presentation of Narrative Epiphany in the Short Stories of James Joyce."

Again and again when we investigate student writing, we see the real ability of students thwarted by the kinds of topics on which they are asked to write. When the student is forced into a false role by the assignment—when, that is, he is asked to manufacture something alien to his own interests and desires—when the writing assignment has not grown naturally and inevitably out of classroom discussion and instruction—then the number of mechanical errors, tortuous constructions, and stylistic improprieties multiplies like paper clips. It is easy, of course, to say that a student must write about what interests him, but it is much less easy to know at all times what that is and, more importantly, how the teacher can extend his range of interests. Consequently the teacher of writing must be forever on the alert for new topics and these must be presented with a stimulating freshness which has been largely developed through class discussion. The new programs in composition are finally asking students to write on sensible subjects.

Furthermore, in good composition programs students are being asked to write papers of sensible length. In very few places the student is still being assigned to write the 1,000-word theme; 350 to 500 words seems a more reasonable amount, if we want a student's genuine effort; and a number of teachers, the realistic ones, are willing to settle most of the time for a good paragraph or two, particularly if the writing has been done in class, where, in my judgment, most of it should be done. It is absurd to expect a high school youngster to turn out 500 words of clear, orderly expository prose in a 45-minute classroom period, and the teacher who makes such a demand needs to return to college for a course in advanced composition. The movement in the high school English course at present is toward shorter papers and more of them; and this applies particularly to that monster of every springtime, the research paper. That great mosaic of rephrasing, borrowings, and downright thefts is on its last legs. This is not to say that teachers of English are refusing the obligation to give their students some instruction in the techniques of research; in the use of reference materials, the card catalogue, and *Readers Guide;* or that they are rejecting the student's need to do some work in footnoting and bibliographical practices. But they have discovered that these ends can be accomplished quite as effectively with a short paper as with a long one of 4,000 to 5,000 words. Here, as I see it, the high school teacher is taking his lead from the college teacher; for the college term paper seems to be getting shorter and shorter, as the students are enjoined to resist secondary source material.

Rhetoric Being Revived

In an essay titled "Live Students and Dead Education: Why The High School Must Be Revived," Oscar Handlin writes, "The disappearance of what a century ago was known as rhetoric has had a deplorable effect in the broken sentences and indirect, ambiguous phraseology characteristic of American speech."[3] I look forward to the opportunity some time this year to tell Professor Handlin that there is a very noticeable revival of rhetoric taking place in many of our high school English classes. Students are being helped through their instruction to see the art of language. They are learning that the way of making an assertion is quite as important as what is said. They are learning about the importance of sentence variety, figurative language, prose rhythm, transition, emphasis, juxtaposition, parenthesis, and other matters considered quaint and formal in the decades of the immediate past. In other words, students, looking positively and constructively at language achievement—looking, that is, at the tremendous variety of both grammatical and rhetorical sentence patterns available to the writer and speaker of effective English—are being helped to see that there are no mysteries about writing good prose; to see, in short, through an analysis of good prose in which interesting devices are observed and named, that they can do it. "Poets are born, not made," writes Sir Herbert Read in *English Prose Style*, "but the ability is given to every man of average intelligence to write clear, orderly prose."[4] The revival of rhetoric in the school is, to me, one of the most salutary developments in today's composition program.

But one writes hopefully of all these matters with some sense of dishonesty and fraud. To say that all these activities are going on, or even just beginning, is not quite true. Undoubtedly it would be more accurate to say, "This is the picture as the teachers of English would have it; this is what they want to be doing." For the most part, they are not able to come anywhere near the kind of program I have outlined. Why not? Again Dr. Conant's book is instructive. The high school English teacher, says Dr. Conant, in order to accomplish an adequate composition program, should not meet more than 100 students each day; in other words, four classes of 25 students each.[5]

The reality of the hour is another matter. It would be a rare public high school in America where all English teachers have only four classes of 25 students each. In this respect some geographical areas are more fortunate than others, but it would not be unusual in any part of the country to find high school teachers of English handling five or six classes daily, with from 35 to 45 students in each class. The number of students each English teacher meets daily, as Dr. Conant observed to his real distress in his visits to the 50 comprehensive high schools, was more likely to be from 150 to 200. And where such teacher loads exist, an adequate program in composition is impossible.

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[3] *The Atlantic Monthly*, September 1961, p. 33.
[4] New York: Pantheon Books, Inc., 1952.
[5] *Op. cit.*, p. 51.

Even when the Conant ideal is reached, the marking burden is still excessive. In the issue of September 14, 1959, *Time* reported: "To produce one student theme a week, Conant suggested that no English teacher should handle more than 100 students. But correcting 100 themes at 10 minutes each takes 17 hours of work—2½ hours seven nights a week. Chicago would need 330 more teachers, adding $2,300,000 to the budget." And even if boards of education were willing and able to appropriate such additional expenditures, the teachers could not be found. We are not training teachers of English in anything like sufficient numbers to meet a demand of such magnitude. Where is the school to go for help?

Plainly, it must go outside the school, to the community at large. The school has always felt privileged to draw on the resources of the community for a variety of needs, particularly in the fields of vocational training, homemaking, driver education, and others. But there has been some timidity or wholly understandable caution about asking the community to assist the academic program. Problems of standards of preparation, training, and even accreditation immediately arise, along wtih a proliferation of bureaucratic details requiring another corps of secretaries and clerks.

The assistance which the school must seek has to be of a professional noncompetitive nature; the academic status of the teacher must in no way be challenged. Only distress can result from any recruitment of the community which makes teacher substitutes of men and women who were not responsibly trained as teachers. If the effective teaching of compostion requires more teachers of English, then, ultimately, more teachers we must have, and it is a nation's moral responsibility to see that we get them.

Meanwhile, the teachers are not available, and if the composition program in the high school is to be an adequate one, our teachers must have some assistance. Temporary or stopgap measures must be introduced. In every community there are housewives who were English majors in college or even, possibly, former teachers of English, or former editorial assistants on newspapers and magazines. In spite of family obligations they have free hours each week which can profitably be spent in community service. With training and orientation they can read English compositions.

And read them well. At the Harvard Graduate School of Education we have tested the use of lay readers or composition aides in four communities, and we have given consultant advice to a number of other schools. The experiment, originally the idea of Floyd Rinker, was designed to utilize the services of women in the communities of Newton, Concord, and Quincy, Mass., and Cleveland Heights, Ohio, as assistants in composition to teachers of English.

In other words, these were lay readers who worked for teachers by doing the routine tasks of evaluating student prose. Cautious at first about the range of their efficiency, readers were inclined to do only the spade work of marking flagrant errors in mechanics—grammar, spelling, punctuation. But as they became an intimately functioning part of the English course—through visits to classes and through conferences with teachers and students—they were able to assume the whole burden of estimating student accomplishment, even in some cases to the point of determining the final grade. Several teachers have attested confidence in readers to the extent of returning student papers without examination of the reader's work.

Whatever skepticism the reader may have about bringing lay readers from the community into the school to do the important work of marking student themes is understandable. And, of course, we have never said that it is the most desirable solution of the problem (which is that classes should be smaller). But we are convinced that lay readers can operate efficiently. The best proof of the success of our program is that the communities in which we tested the idea with foundation and governmental subsidy have all continued the program—with additional readers—at Board of Education expense. At Cleveland Heights, one of the most forward-looking school communities I know, the number of readers was tripled in one year.

Revision of the English curriculum is not exclusively a matter of what is being done in composition. Quite as exciting are the developments in literature and in language study generally. In literature one begins to see, unexpectedly perhaps, a move in the direction of uniformity or a standardized curriculum—an approved list of books. The evidence to support this notion is admittedly slight; it consists of little more than a few scattered statements by individuals, several of whom have associations with the Council for Basic Education. But it is notable that the Committee on English of the Advanced Placement Program has recently issued a revision of its course and examination description in which it indicates very specifically the areas in literature in which students taking the Advanced Placement Examinations in English in the future can expect to be tested.[6] The committee does not mean that the list should be rigidly prescriptive—of course not. But the results of issuing such a list are not difficult for anyone to imagine, if he has had any connections with high school English teachers. Make no mistake about it. Next May quite a number of able high school youngsters will go to the Advanced Placement Examination in English meticulously prepared in every selection even hinted at by the list.

If this trend toward uniformity really exists, it is interesting to wonder how it came about, for to many teachers it will surely seem a complete reversal of what they had hoped for. The advent of the paperback book had seemed to signal the end of the tyranny of the anthology and the beginning of a wonderful freedom whereby teachers of English could use in the literature program just about anything they wished.

Possibly it is this very freedom, verging in a number of systems on anarchy, which has created the feeling that a literary experience should be common, at least to college-bound youngsters. Dissatisfied with the snippets and fragments of the anthology, the teachers turned to whole books. And rightly so. But freed from the restraints of the traditional, of literary works quite exhausted and threadbare, teachers gravitated toward the delights of contemporary literature. Suddenly the high school discovered the esoteric and the avantgarde, and where students were once reading Scott and Dickens and Hawthorne, they were now reading Faulkner, Kafka, and Camus. A fairly recent book on literature for the high school includes on one of its reading lists *The Counterfeiters* by André Gide; the reading list for the Rutgers Plan contains *By Love Possessed* by James Gould Cozzens, and there is a teacher of eighth grade English in Massachusetts who asks his students in the course of one week to read three novels by Henry James!

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[6] *Advanced Placement Program: English,* New York: College Entrance Examination Board, 1961.

These, to be sure, are extremes, and the national picture is probably not much different from what it was 25 or even 50 years ago. *Silas Marner*, *A Tale of Two Cities*, and *The Idylls of the King* are still very much in evidence. I would submit, however, that there may be more of the highly specialized programs in action than we think, and that many students will be coming to college increasingly familiar with advanced modern literature. Sensing this, some members of the profession are beginning to plead for the mastery of a number of works of the past which, by the common judgment of college and secondary school teachers of English, provide the foundation upon which successful reading of later works can be built. These educators do not prescribe a return to the anthology, or even to chronological treatment, but only to a body of literary works which constitute our cultural heritage.

Schools Neglect Modern Authors

Yet those who plead for increased use of modern literature have a strong point. The failure of the secondary school to make use of the distinguished writing of our time is a serious cultural lag. The giants of twentieth century English and American letters are still pretty much outside the secondary school curriculum, except, perhaps, in the independent schools. One can agree with those who want adequate attention paid to the classics of the past, but one can still hold that there are works of contemporary writers admirably suited to the high school. Thorough acquaintance with Faulkner, with Hemingway, with T. S. Eliot, with E. M. Forster, and with D. H. Lawrence reveals many short pieces and even several full-length works which students can read and discuss with understanding, with cultural and esthetic profit, and without embarrassment to student, teacher, or parent. Our literature, particularly our fiction and our drama, is an almost universally realistic literature, but we shall win very little of the confidence of our students if we run away from it or refuse to admit that it exists. A more rewarding procedure is to help the students approach the realism in the proper frame of mind. If we are to return to a common literary experience for all college-bound high school students, there is every reason why our list of approved books should contain some of the classics of our own time. But the choice must be critically and comprehensively made: *The Catcher in the Rye*, alone, is not quite enough.

Teachers of English divide on the use of continental literature in translation in the English course. Those who oppose do so either because they feel that to read a work in translation is not really to read it as literature, or because they consider a foreign work inappropriate to a course which concentrates on accomplishment in the specific language of English. Some schools, often at the request of students who want to know the ideas of writers of other countries, have organized foreign works into a "great books course" which is offered as an elective. This arrangement is not always possible, however, and teachers of English—particularly those who follow a thematic treatment of literature—are bringing more and more of the works of continental authors into the course of study. Over the three-year period of senior high school, a youngster in one of today's schools might read *An Enemy of the People* by Ibsen, *Crime and Punishment* by Dostoevsky, *Père Goriot* by Balzac, or even possibly *Madame Bovary* by Flaubert. The Commission on English of the College Entrance Examination Board recommends some attention to foreign work in translation, so it seems safe to say that the student of the immediate future will come to college having at least a nodding acquaintance with some of the authors of Europe, if not of Asia. The necessity of his getting to know our international neighbors better, in the interests of peace, friendliness, and cooperation, creates a sense of urgency which curriculum builders at the moment at least seem eager to serve.

What happens to the literary work in the classroom has also undergone some change in recent years. Again taking their cue from the colleges, the schools have tended to favor the careful reading of a limited number of texts rather than the wholesale and superficial reading of many. Close textual analysis of a poem or story, exegesis, and *explication de texte,* resulting probably from the academic interest in the New Criticism, have found their way down into the high school, chiefly in the instructional techniques of teachers recently out of liberal arts colleges. This, for the most part, is all to the good, especially with college-bound students; for the teaching of literature had become sluggishly biographical, historical, and even worse, homiletic. But there have been excesses, some exasperating, some painful, some irresponsible. On the secondary level no one approach to the teaching of literature should prevail. Some attention to chronology is valuable and, to college-bound youngsters, necessary. Organization of a number of works of literature around an important theme in human relations will keep students aware that literature deals with the major issues of their lives. And the study of genres, each with its own record of development and experiment, can help students to see that art is a matter of effort, intelligence, judgment, taste, and energy. A literature program which gives the student no sense of the art of the work is only half a program. Resistance to form would seem to be a thing of the progressive past in American secondary school education. The College Board Commission on English recommends that we now strive for "A sound appreciation of literary forms, a useful vocabulary of literary terms, and a secure command of the ideas and art of a respectable number of major works."[7]

Literary study in the high school seems to have rediscovered enjoyment. Some years ago one began to get the impression that our teachers of literature had never heard that readers of it are supposed to take pleasure from the experience. Partly because of economic tensions, partly because of racial persecution, partly because of the novelties of the new psychology, we began to make a variety of demands of our authors which some of them were unable or even unwilling to meet. We were merciless—even to the authors of the past. If we could not prove that they were serving, in the most explicit fashion, the social needs of the underprivileged, the freedom of minorities, and the clinical therapy of the maladjusted, we

[7] *Preparation in English for College-Bound Students*, New York: College Entrance Examination Board, 1960.

had no use for them. The English classroom was sometimes a curious place; the teacher functioned as reformer, arbitrator, and analyst. Literature became a grim business, and the list of useful authors diminished. Rereading the literary criticism of that time, a criticism which unfortunately guided much of the teaching of literature, is a shocking experience. Could we ever have been really so naive as to accept the judgments of Vernon Louis Parrington on Hawthorne and Melville? Did we really believe with Granville Hicks that the fiction of Dos Passos is more socially responsible and therefore esthetically superior to that of Hemingway and Faulkner? Did we really agree with Jack Lindsay that Dickens was at heart a Marxist or with half a dozen social patriots that the only truly democratic message in our poetry is to be found in Whitman?

All that agitation is gone. History—the terrible history of our time—taught us that any scheme of interpretation which narrows the dimensions of the human spirit is egregious; that civilization is not exclusively a matter of idealistic sober dedications; that joy and frivolity and even trivia are essential to growth and nobility. The refined and the fastidious—in manners, in education, in art, in the traffic with a great idea or equally with the elegant turning of a quatrain—have their social uses, too. And their democratic ones. It is not an irony and it is not an accident that the revaluation of Henry James took place chiefly in our colleges during the influx of the veterans returning from World War II. After every war, as Karl Shapiro said, there is a conscience to come back to—I might add, "and good taste, as well." The students who will be entering our colleges shortly may seem to be enjoying literature again. Maybe the people who wrote those dreadfully titled textbooks of several decades ago were right: reading can be fun!

Any discussion of the changing college preparatory curriculum in English must pay some attention to structural linguistics or linguistic analysis, or linguistic science, or the "new grammar," as it is variously called. The Commission on English recommends an emphasis on this kind of study; and when the English Institutes get under way next year linguistic study will occupy quite as important a place as composition and literature. For teachers of English, linguistics is the prestige subject of the hour, in somewhat the same way that semantics was 15 or 20 years ago, and there is no doubt that it will have a powerful shaping effect on the English curriculum in the next few years. To the layman, so far at least, it is likely to seem an extraordinarily difficult subject and, if he comes up close, perhaps an amorphous one. There are different kinds of linguists: some are pure theorists, scientists who are concerned only with constructing an accurate description of language practice; others are very practical investigators, teachers for the most part, who are concerned with the application of theory to the use of language in communication. Both have in common the settled and linguistically sound conviction that traditional grammar is not an accurate description of the way in which our language functions. Its definitions are, at best, inadequate and its terminology is obsolete. Furthermore, it does not allow for the many vagaries in human idiom and phraseology which constantly extend the structural range of the English sentence; it pays insufficient, if any, attention to the values of pitch, stress, and intonation in the spoken language; and it does not acknowledge that, since usage determines "correctness," the *spoken* language is the language.

This is the most elementary possible comment on what the linguists stand for. The literature of the subject is already vast and complex, and the names of the major linguists are on the tongues of English teachers everywhere. But not all teachers are agreed on the kind and amount of use which the classroom can make of the material. Some of the linguists—like Nelson Francis, Noam Chomsky, and James H. Sledd—have already pleaded with the teachers to be cautious, particularly not to make claims for the subject which the data of research cannot yet support. For example, we have no data to substantiate any claim that attention to linguistic science can improve a student's composition work. Yet among teachers, and particularly at teachers' conferences designed to acquaint teachers with linguistics, this is one of the major claims being made for it. We had no data to prove that traditional grammar could help the composition program either. One claim certainly can be made, however: structural linguistics will make it possible for the student to speak with greater accuracy about what he is doing when he puts sentences together.

Whatever the future, it is certainly to be expected that the teaching of grammar can no longer remain the rigidly traditional subject that it has been in many places for far too many years. Some teachers are trying, for the time being, to work out a sensible compromise between the old and the new, retaining what is truly descriptive and functional in the old and adapting and applying what is truly scientific and practical in the new. Some, following the suggestions of several of the linguists themselves, are teaching structural linguistics for its own sake—as a humanistic science dealing with the whole history of language and communication. The findings of the linguists are fascinating; they have been listening attentively to modern man's way with the English sentence. Sometimes their discoveries seem insignificant and of no consequence to language study or communication. Most of the time, however, they are making us aware that many of the assumptions about English which we have been passing on in the classroom and have required that youngsters memorize to the point of tedium and large scale disaffection with all education—thus causing them to leave school—are untruths. These must be corrected and revised.

Here then, as I see them, are the changes currently taking place in the college preparatory curriculum in English. Undoubtedly there are others, but I regard the ones I have mentioned as the major ones. I have not commented on speaking and listening, great favorites with the language arts people. I have not done so because in most areas that I am familiar with speaking is now a course wholly separate from English, with its own corps of specially trained instructors. This, in my judgment, is as it should be. My own preference about listening is to make it part of the units in semantics, argumentation, and critical thinking; and I prefer that these be joined to the instruction in persuasive writing. Also in connection with listening, I would caution English teachers to stay within their own domain and not stray into the sometimes greener-looking pastures of the social studies teacher. There is already far too much for the English teacher to do. I would like to be able to report here that the most important change in the college preparatory curriculum in English is that there is going to be a great deal less in it.

But, everything considered, it is really an embarrassment of riches we labor with. Each activity in the English course of study has its own special excitement, because even when mistaken, all are part of the wholesale, constructive effort to help men communicate richly and fully with one another. A review of "La Dolce Vita" in the June 3, 1961, issue of the Jesuit magazine *America* says that the point this film wants to make is that each of the characters is a half-person because he cannot talk penetratingly and fully to anyone else. It may very well be true that the materialistic successes of modern civilization force an alienation which makes us half-persons, who, through loneliness and isolation, sometimes do violence to others and to ourselves. But, if so, the burden of the teacher who works with the nobility of literature and the precision of communication is a truly fearsome one. It is nothing less than to keep men whole.

12

Evaluation for Course Improvement

LEE J. CRONBACH · UNIVERSITY OF ILLINOIS

The national interest in improving education has generated several highly important projects attempting to improve curricula, particularly at the secondary-school level. In conferences of directors of "course content improvement" programs sponsored by the National Science Foundation, questions about evaluation are frequently raised.[1] Those who inquire about evaluation have various motives, ranging from sheer scientific curiosity about classroom events to a desire to assure a sponsor that money has been well spent. While the curriculum developers sincerely wish to use the skills of evaluation specialists, I am not certain that they have a clear picture of what evaluation can do and should try to do. And, on the other hand, I am becoming convinced that some techniques and habits of thought of the evaluation specialist are ill-suited to current curriculum studies. To serve these studies, what philosophy and methods of evaluation are required? And particularly, how must we depart from the familiar doctrines and rituals of the testing game?

Decisions Served by Evaluation

To draw attention to its full range of functions, we may define "evaluation" broadly as the *collection and use of information to make*

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decisions about an educational program. This program may be a set of instructional materials distributed nationally, the instructional activities of a single school, or the educational experiences of a single pupil. Many types of decision are to be made, and many varieties of information are useful. It becomes immediately apparent that evaluation is a diversified activity and that no one set of principles will suffice for all situations. But measurements specialists have so concentrated upon one process—the preparation of pencil-and-paper achievement tests for assigning scores to individual pupils—that the principles pertinent to that process have somehow become enshrined as *the* principles of evaluation. "Tests," we are told, "should fit the content of the curriculum." Also, "only those evaluation procedures should be used that yield reliable scores." These and other hallowed principles are not entirely appropriate to evaluation for course improvement. Before proceeding to support this contention, I wish to distinguish among purposes of evaluation and relate them to historical developments in testing and curriculum making.

We may separate three types of decisions for which evaluation is used:

1. Course improvement: deciding what instructional materials and methods are satisfactory and where change is needed.
2. Decisions about individuals: identifying the needs of the pupil for the sake of planning his instruction, judging pupil merit for purposes of selection and grouping, acquainting the pupil with his own progress and deficiencies.
3. Administrative regulation: judging how good the school system is, how good individual teachers are, etc.

Course improvement is set apart by its broad temporal and geographical reference; it involves the modification of recurrently used materials and methods. Developing a standard exercise to overcome a misunderstanding would be course improvement, but deciding whether a certain pupil should work through that exercise would be an individual decision. Administrative regulation likewise is local in effect, whereas an improvement in a course is likely to be pertinent wherever the course is offered.

It was for the sake of course improvement that systematic evaluation was first introduced. When that famous muckraker Joseph Rice gave the same spelling test in a number of American schools, and so gave the first impetus to the educational testing movement, he was interested in evaluating a curriculum. Crusading against the extended spelling drills that then loomed large in the school schedule —"the spelling grind"—Rice collected evidence of their worthlessness so as to provoke curriculum revision. As the testing movement developed, however, it took on a different function.

The greatest expansion of systematic achievement testing occurred in the 1920's. At that time, the content of any course was taken pretty much as established and beyond criticism save for small shifts of topical emphasis. At the administrator's direction, standard tests covering this curriculum were given to assess the efficiency of the teacher or the school system. Such administrative testing fell into disfavor when used injudiciously and heavyhandedly in the 1920's and 1930's. Administrators and accrediting agencies fell back upon descriptive features of the school program in judging adequacy. Instead of collecting direct evidence of educational impact, they judged schools in terms of size of budget, student-staff ratio, square feet of laboratory space, and the number of advanced credits accumulated by the teacher. This tide, it appears, is about to turn. On many university campuses, administrators wanting to know more about their product are installing "operations research offices." Testing directed toward quality control seems likely to increase in the lower schools as well, as is most forcefully indicated by the statewide testing just ordered by the California legislature.

After 1930 or thereabouts, tests were given almost exclusively for judgments about individuals: to select students for advanced training, to assign marks within a class, and to diagnose individual competences and deficiencies. For any such decisions, one wants precise and valid comparisons of one individual with other individuals or with a standard. Much of test theory and test technology has been concerned with making measurements precise. Important though precision is for most decisions about individuals, I shall argue that in evaluating courses we need not struggle to obtain precise scores for individuals.

While measurers have been well content with the devices used to make scores precise, they have been less complacent about validity. Prior to 1935 the pupil was examined mostly on factual knowledge and mastery of fundamental skills. Tyler's research and writings of that period developed awareness that higher mental processes are not evoked by simple factual tests, and that instruction that promotes factual knowledge may not promote—indeed, may interfere with—other more important educational outcomes. Tyler, Lindquist, and their students demonstrated that tests can be designed to measure general educational outcomes such as ability to comprehend scientific method. Whereas a student can prepare for a factual test only through a course of study that includes the facts tested, many different courses of study may promote the same *general* understandings and attitudes. In evaluating today's new curricula, it will clearly be important to appraise the student's general educational growth, which curriculum developers say is more important than mastery of the specific lessons presented. Note, for example, that the Biological Sciences Curriculum Study offers three courses with substantially different "subject matter" as alternative routes to much the same educational ends.

Although some instruments capable of measuring general outcomes were prepared during the 1930's, they were never very widely employed. The prevailing philosophy of the curriculum, particularly among "progressives," called for developing a program to fit local requirements, capitalizing on the capacities and experiences of local pupils. The faith of the 1920's in a "standard" curriculum was replaced by a faith that the best learning experience would result from teacher-pupil planning in each classroom. Since each teacher or each class could choose different content and even different objectives, this philosophy left little place for standard testing.

Many evaluation specialists came to see test development as a strategy for training the teacher in service, so that the process of test making came to be valued more than the test—or the test data—that resulted. The following remarks by Bloom (1961) are representative of a whole school of thought:[2]

> The criterion for determining the quality of a school and its educational functions would be the extent to which it achieves the objectives it has set for itself. . . . Our experiences suggest that unless the school has translated the objectives into specific and operational definitions, little is

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[2] Elsewhere, Bloom's paper discusses evaluation for the new curricula. Attention may also be drawn to Tyler's highly pertinent paper (1951).

> likely to be done about the objectives. They remain pious hopes and platitudes. . . . Participation of the teaching staff in selecting as well as constructing evaluation instruments has resulted in improved instruments on one hand and on the other hand it has resulted in clarifying the objectives of instruction and in making them real and meaningful to teachers. . . . When teachers have actively participated in defining objectives and in selecting or constructing evaluation instruments they return to the learning problems with great vigor and remarkable creativity. . . . Teachers who have become committed to a set of educational objectives which they thoroughly understand respond by developing a variety of learning experiences which are as diverse and as complex as the situation requires.

Thus "evaluation" becomes a local, and beneficial, teacher-training activity. The benefit is attributed to thinking about what data to collect. Little is said about the actual use of test results; one has the impression that when test-making ends, the test itself is forgotten. Certainly there is little enthusiasm for refining tests so that they can be used in other schools, for to do so would be to rob those teachers of the benefits of working out their own objectives and instruments.

Bloom and Tyler describe both curriculum making and evaluation as integral parts of classroom instruction, which is necessarily decentralized. This outlook is far from that of "course improvement." The current national curriculum studies assume that curriculum making can be centralized. They prepare materials to be used in much the same way by teachers everywhere. It is assumed that having experts draft materials, and revising these after tryout, produces better instructional activities than the local teacher would be likely to devise. In this context it seems wholly appropriate to have most tests prepared by a central staff, and to have results returned to that staff to guide further course improvement.

When evaluation is carried out in the service of course improvement, the chief aim is to ascertain what effects the course has—that is, what changes it produces in pupils. This is not to inquire merely whether the course is effective or ineffective. Outcomes of instruction are multidimensional, and a satisfactory investigation will map out the effects of the course along these dimensions separately. To agglomerate many types of post-course performance into a single score is a mistake, since failure to achieve one objective is masked by success in another direction. Moreover, since a composite score embodies (and usually conceals) judgments about the importance of the various outcomes, only a report that treats the outcomes separately can be useful to educators who have different value hierarchies.

The greatest service evaluation can perform is to identify aspects of the course where revision is desirable. Those responsible for developing a course would like to present evidence that their course is effective. They are intrigued by the idea of having an "independent testing agency" render a judgment on their product. But to call in the evaluator only upon the completion of course development, to confirm what has been done, is to offer him a menial role and to make meager use of his services. To be influential in course improvement, evidence must become available midway in curriculum development, not in the home stretch when the developer is naturally reluctant to tear open a supposedly finished body of materials and techniques. Evaluation, used to improve the course while it is still fluid, contributes more to improvement of education than evaluation used to appraise a product already placed on the market.

Insofar as possible, evaluation should be used to understand how the course produces its effects and what parameters influence its effectiveness. It is important to learn, for example, that the outcome of programed instruction depends very much upon the attitude of the teacher; indeed, this may be more important than to learn that on the average such instruction produces slightly better or worse results than conventional instruction.

Hopefully, evaluation studies will go beyond reporting on this or that course, and help us to understand educational learning. Such insight will in the end contribute to the development of all courses rather than just of the course under test. In certain of the new curricula, there are data to suggest that aptitude measures correlate much less with end-of-course achievement than they do with achievement on early units (Ferris, 1962). This finding is not well confirmed, but is highly significant if true. If it is true for the new curricula and only for them it has one implication; if the same effect appears in traditional courses, it means something else. Either way, it provides food for thought for teachers, counselors, and theorists. Evaluation studies should generate knowledge about the nature of the abilities that constitute educational goals. Twenty years after the Eight-Year Study of the Progressive Education Association, its testing techniques are in good repute, but we still know very little about what these instruments measure. Consider "Applications of Principles in Science." Is this in any sense a unitary ability? Or has the able student only mastered certain principles one by one? Is the ability demonstrated on a test of this sort more prognostic of any later achievement than is factual knowledge? Such questions ought to receive substantial attention, though to the makers of any one course they are of only peripheral interest.

The aim to compare one course with another should not dominate plans for evaluation. To be sure, decision makers have to choose between courses, and any evaluation report will be interpreted in part comparatively. But formally designed experiments pitting one course against another are rarely definitive enough to justify their cost. Differences between average test scores resulting from different courses are usually small, relative to the wide differences among and within classes taking the same course. At best, an experiment never does more than compare the present version of one course with the present version of another. A major effort to bring the losing contender nearer to perfection would be very likely to reverse the verdict of the experiment.

Any failure to equate the classes taking the competing courses will jeopardize the interpretation of an experiment and such failures are almost inevitable. In testing a drug, we know that valid results cannot be obtained without a double-blind control in which the doses for half the subjects are inert placebos; the placebo and the drug look alike, so that neither doctor nor patient knows who is receiving medication. Without this control the results are useless even when the state of the patient is checked by completely objective indices. In an educational experiment it is difficult to keep pupils unaware that they are an experimental group. And it is quite impossible to neutralize the biases of the teacher as those of the doctor are neutralized in the double-blind design. It is thus never certain whether any observed advantage is attributable to the educational innovation as such, or to the greater energy that teachers and students put forth when a method is fresh and "experimental." Some have contended that any course, even the most excellent, loses much of its potency as soon as success enthrones it as "the traditional method."[3]

Since group comparisons give equivocal results, I believe that a formal study should be designed primarily to determine the post-course performance of a well-described group, with respect to many important objectives and side effects. Ours is a problem like that of the engineer examining a new automobile. He can set himself the task of defining its performance characteristics and its dependability. It would be merely distracting to put his question in the form: "Is this car better or worse than the competing brand?" Moreover, in an experiment where the treatments compared differ in a dozen respects, no understanding is gained from the fact that the experiment shows a numerical advantage in favor of the new course. No one knows which of the ingredients is responsible for the advantage. More analytic experiments are much more useful than field trials applying markedly dissimilar treatments to different groups. Small-scale, well-controlled studies can profitably be used to compare alternative versions of the same course; in such a study the differences between treatments are few enough and well-enough defined that the results have explanatory value.

The three purposes—course improvement, decisions about individuals, and administrative regulation—call for measurement procedures having somewhat different qualities. When a test will be used to make an administrative judgment on the individual teacher, it is necessary to measure thoroughly and with conspicuous fairness; such testing, if it is to cover more than one outcome, becomes extremely time-consuming. In judging a course, however, one can make satisfactory interpretations from data collected on a sampling basis, with no pretense of measuring thoroughly the accomplishments of any one class. A similar point is to be made about testing for decisions about individuals. A test of individuals must be conspicuously fair, and extensive enough to provide a dependable score for each person. But if the performance will not influence the fate of the individual, we can ask him to perform tasks for which the course has not directly prepared him, and we can use techniques that would be prohibitively expensive if applied in a manner thorough enough to measure each person reliably.

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[3] The interested reader can find further striking parallels between curriculum studies and drug research (see Modell, 1963).

Methods of Evaluation

RANGE OF METHODS. Evaluation is too often visualized as the administration of a formal test, an hour or so in duration, at the close of a course. But there are many other methods for examining pupil performance, and pupil attainment is not the only basis for appraising a course.

It is quite appropriate to ask scholars whether the statements made in the course are consistent with the best contemporary knowledge. This is a sound, even a necessary procedure. One might go on to evaluate the pedagogy of the new course by soliciting opinions, but here there is considerable hazard. If the opinions are based on some preconception about teaching method, the findings will be controversial and very probably misleading. There are no theories of pedagogy so well established that one can say, without tryout, what will prove educative.

One can accept the need for a pragmatic test of the curriculum and still employ opinions as a source of evidence. During the tryout stages of curriculum making, one relies heavily on the teachers' reports of pupil accomplishment—"Here they had trouble"; "This they found dull"; "Here they needed only half as many exercises as were provided"; etc. This is behavior observation even though unsystematic, and it is of great value. The reason for shifting to systematic observation is that this is more impartial, more public, and sometimes more penetrating. While I bow to the historian or mathematician as a judge of the technical soundness of course content, I do not agree that the experienced history or mathematics teacher who tries out a course gives the best possible judgment on its effectiveness. Scholars have too often deluded themselves about their effectiveness as teachers—particularly, have too often accepted parroting of words as evidence of insight—for their unaided judgment to be trusted. Systematic observation is costly, and introduces some delay between the moment of teaching and the feedback of results. Hence systematic observation will never be the curriculum developer's sole source of evidence. Systematic data collection becomes profitable in the intermediate stages of curriculum development, after the more obvious bugs in early drafts have been dealt with.

The approaches to evaluation include process studies, proficiency measures, attitude measures, and follow-up studies. A process study is concerned with events taking place in the classroom, proficiency and attitude measures with changes observed in pupils, and follow-up studies with the later careers of those who participated in the course.

The follow-up study comes closest to observing ultimate educational contributions, but the completion of such a study is so far removed in time from the initial instruction that it is of minor value in improving the course or explaining its effects. The follow-up study differs strikingly from the other types of evaluation study in one respect. I have already expressed the view that evaluation should be primarily concerned with the effects of the course under study rather than with comparisons of courses. That is to say, I would emphasize departures of attained results from the ideal, differences in apparent effectiveness of different parts of the course, and differences from item to item; all these suggest places where the course could be strengthened. But this view cannot be applied to the follow-up study, which appraises effects of the course as a whole and which has very little meaning unless outcomes can be compared with some sort of base rate. Suppose we find that 65 percent of the boys graduating from an experimental curriculum enroll in scientific and technical majors in college. We cannot judge whether this is a high or low figure save by comparing it with the rate among boys who have not had this course. In a follow-up study, it is necessary to obtain data on a control group equated at least crudely to the experimental cases on the obvious demographic variables.

Despite the fact that such groups are hard to equate and that follow-up data do not tell much about how to improve the course, such studies should have a place in research on the new curricula, whose national samples provide unusual opportunity for follow-up that can shed light on important questions. One obvious type of follow-up study traces the student's success in a college course founded upon the high-school course. One may examine the student's grades or ask him what topics in the college course he found himself poorly prepared for. It is hoped that some of the new science and mathematics courses will arouse greater interest than usual among girls; whether this hope is well founded can be checked by finding out what majors and what electives these ex-students pursue in college. Career choices likewise merit attention. Some proponents of the new curricula would like to see a greater flow of talent into basic science as distinct from technology while others would regard this as potentially disastrous; but no one would regard facts about this flow as lacking significance.

Attitudes are prominent among the outcomes course developers are concerned with. Attitudes are meanings or beliefs, not mere expressions of approval or disapproval. One's attitude toward science includes ideas about the matters on which a scientist can be an authority, about the benefits to be obtained from moon shots and studies of monkey mothers, and about depletion of natural resources. Equally important is the match between self-concept and concept of the field: what roles does science offer a person like me? would I want to marry a scientist? and so on. Each learning activity also contributes to attitudes that reach far beyond any one subject, such as the pupil's sense of his own competence and desire to learn.

Attitudes can be measured in many ways; the choices revealed in follow-up studies, for example, are pertinent evidence. But measurement usually takes the form of direct or indirect questioning. Interviews, questionnaires, and the like are quite valuable when not trusted blindly. Certainly, we should take seriously any *un*desirable opinion expressed by a substantial proportion of graduates of a course (e.g., the belief that the scientist speaks with peculiar authority on political and ethical questions, or the belief that mathematics is a finished subject rather than a field for current investigation).

Attitude questionnaires have been much criticized because they are subject to distortion, especially where the student hopes to gain by being less than frank. Particularly if the questions are asked in a context far removed from the experimental course, the returns are likely to be trustworthy. Thus a general questionnaire administered through homerooms (or required English courses) may include questions about liking for various subjects and activities; these same questions administered by the mathematics teacher would give much less trustworthy data on attitude toward mathematics. While students may give reports more favorable than their true beliefs, this distortion is not likely to be greater one year than another, or greater among students who take an experimental course than among those who do not. In group averages, many distortions balance out. But questionnaires insufficiently valid for individual testing can be used in evaluating curricula, both because the student has little motive to distort and because the evaluator is comparing averages rather than individuals.

For measuring proficiency, techniques are likewise varied. Standardized tests are useful. But for course evaluation it makes sense to assign *different* questions to different students. Giving each student in a population of 500 the same test of 50 questions will provide far less information to the course developer than drawing for each student 50 questions from a pool of, say, 700. The latter plan determines the mean success of about 75 representative students on every one of the 700 items; the former reports on only 50 items. (See Lord, 1962) Essay tests and open-ended questions, generally too expensive to use for routine evaluation, can profitably be employed to appraise certain abilities. One can go further and observe individuals or groups as they attack a research problem in the laboratory or work through some other complex problem. Since it is necessary to test only a representative sample of pupils, costs are not as serious a consideration as in routine testing. Additional aspects of proficiency testing will be considered below.

Process measures have especial value in showing how a course can be improved because they examine what happens during instruction. In the development of programed instructional materials, for example, records are collected showing how many pupils miss each item presented; any piling up of errors implies a need for better explanation or a more gradual approach to a difficult topic. Immediately after showing a teaching film, one can interview students, perhaps asking them to describe a still photograph taken from the film. Misleading presentations, ideas given insufficient emphasis, and matters left unclear will be identified by such methods. Similar interviews can disclose what pupils take away from a laboratory activity or a discussion. A process study might turn attention to what the teacher does in the classroom. In those curricula that allow choice of topics, for example, it is worthwhile to find out which topics are chosen and how much time is allotted to each. A log of class activities (preferably recorded by a pupil rather than the teacher) will show which of the techniques suggested in a summer institute are actually adopted, and which form "part of the new course" only in the developer's fantasies.

MEASUREMENT OF PROFICIENCY. I have indicated that I consider item data to be more important than test scores. The total score may give confidence in a curriculum or give rise to discouragement, but it tells very little about how to produce further improvement. And, as Ferris (1962) has noted, such scores are quite likely to be mis- or overinterpreted. The score on a single item, or on a problem that demands several responses in succession, is more likely than the test score to suggest how to alter the presentation. When we accept item scores as useful, we need no longer think of evaluation as a one-shot, end-of-year operation. Proficiency can be measured at any moment, with particular interest attaching to those items most related to the recent lessons. Other items calling for general abilities can profitably be administered repeatedly during the course (perhaps to different random samples of pupils) so that we can begin to learn when and from what experiences change in these abilities comes.

In course evaluation, we need not be much concerned about making measuring instruments fit the curriculum. However startling this declaration may seem, and however contrary to the principles of evaluation for other purposes, this must be our position if we want to know what changes a course produces in the pupil. An ideal evaluation would include measures of all the types of proficiency that might reasonably be desired in the area in question, not just the selected outcomes to which this curriculum directs substantial attention. If you wish only to know how well a curriculum is achieving *its* objectives, you fit the test to the curriculum; but if you wish to know how well the curriculum is serving the national interest, you measure all outcomes that might be worth striving for. One of the new mathematics courses might disavow any attempt to teach numerical trigonometry, and indeed, might discard nearly all computational work. It is still perfectly reasonable to ask how well graduates of the course can compute and can solve right triangles. Even if the course developers went so far as to contend that computational skill is no proper objective of secondary instruction, they will encounter educators and laymen who do not share their view. If it can be shown that students who come through the new course are fairly proficient in computation despite the lack of direct teaching, the doubters will be reassured. If not, the evidence makes clear how much is being sacrificed. Similarly, when the biologists offer alternative courses emphasizing microbiology and ecology, it is fair to ask how well the graduate of one course can understand issues treated in the other. Ideal evaluation in mathematics will collect evidence on all the abilities toward which a mathematics course might reasonably aim; likewise in biology, English, or any other subject.

Ferris states that the ACS Chemistry Test, however well constructed, is inadequate for evaluating the new CBA and CHEM programs because it does not cover their objectives. One can agree with this without regarding the ACS test as inappropriate to use with these courses. It is important that this test not stand *alone*, as the sole evaluation device. It will tell us something worth knowing, namely, just how much "conventional" knowledge the new curriculum does or does not provide. The curriculum developers deliberately planned to sacrifice some of the conventional attainments and have nothing to fear from this measurement, competently interpreted (particularly if data are examined item by item).

The demand that tests be closely matched to the aims of a course reflects awareness that examinations of the usual sort "determine what is taught." If questions are known in advance, students give more attention to learning their answers than to learning other aspects of the course. This is not necessarily detrimental. Wherever it is critically important to master certain content, the knowledge that it will be tested produces a desirable concentration of effort. On the other hand, learning the answer to a set question is by no means the same as acquiring understanding of whatever topic that question represents. There is therefore a possible advantage in using "secure" tests for course evaluation. Security is achieved only at a price: One must prepare new tests each year, and cannot make before-and-after comparisons with the same items. One would hope that the use of different items with different students, and the fact that there is less incentive to coach when no judgment is to be passed on the pupils and the teachers, would make security a less critical problem.

The distinction between factual tests and tests of higher mental processes, as elaborated for example in the *Taxonomy of Educational Objectives*, is of some value in planning tests, although classfying items as measures of knowledge, application, original problem solving, etc., is difficult and often impossible. Whether a given response represents rote recall or reasoning depends upon how the pupil has been taught, not solely upon the question asked. One might, for example, describe a biological environment and ask for predictions regarding the effect of a certain intervention. Students who had never dealt with ecological data would succeed or fail according to their general ability to reason about complex events; those who had studied ecological biology would be more likely to succeed, reasoning from specific principles; and those who had lived in such an ecology or read about it might answer successfully on the basis of memory. We rarely, therefore, will want to test whether a student "knows" or "does not know" certain material. Knowledge is a matter of degree. Two persons may be acquainted with the same facts or principles, but one will be more expert in his understanding, better able to cope with inconsistent data, irrelevant sources of confusion, and apparent exceptions to the principle. To measure intellectual competence is to measure depth, connectedness, and applicability of knowledge.

Too often, test questions are course-specific, stated in such a way that only the person who has been specifically taught to understand what is being asked for can answer the question. Such questions can usually be identified by their use of conventions. Some conventions are commonplace, and we can assume that all the pupils we test will know them. But a biology test that describes a metabolic process with the aid of the $\rightleftharpoons$ symbol presents difficulties for students who can think through the scientific question about equilibrium but are unfamiliar with the symbol. A trigonometry problem that requires use of a trigonometric table is unreasonable, unless we want to test familiarity with the conventional names of functions. The same problem in numerical trigonometry can be cast in a form clear to the average pupil *entering* high school; if necessary, the tables of functions can be presented along with a comprehensible explanation. So stated, the problem becomes course-independent. It is fair to ask whether graduates of the experimental course can solve such problems, not previously encountered, whereas it is pointless to ask whether they can answer questions whose language is strange to them. To be sure, knowledge of a certain terminology is a significant objective of instruction, but for course evaluation testing of terminology should very likely be separated from testing of other understandings. To appraise understanding of processes and relations, the fair question is one comprehensible to a pupil who has not taken the course. This is not to say that he should know the answer or the procedure to follow in attaining the answer, but he should understand what he is being asked. Such course-independent questions can be used as standard instruments to investigate any instructional program.

Pupils who have not studied a topic will usually be less facile than those who have studied it. Graduates of my hypothetical mathematics course will take longer to solve trigonometry problems than will those who have studied trig. But speed and power should not be confused; in intellectual studies, power is almost always of greatest importance. If the course equips the pupil to deal correctly even though haltingly with a topic not studied, we can expect him to develop facility later when that topic comes before him frequently.

The chief objective in many of the new curricula seems to be to develop aptitude for mastering new materials in the field. A biology course cannot cover all valuable biological content, but it may reasonably aspire to equip the pupil to understand descriptions of unfamiliar organisms, to comprehend a new theory and the reasoning behind it, and to plan an experiment to test a new hypothesis. This is transfer of learning. It has been insufficiently recognized that there are two types of transfer. The two types shade into one another, being arranged on a continuum of immediacy of effect; we can label the more immediate pole applicational transfer, and speak of slower-acting effects as gains in aptitude (cf. Ferguson, 1954).

Nearly all educational research on transfer has tested immediate performance on a partly-new task. We teach pupils to solve equations in *x*, and include in the test equations stated in *a* or *z*. We teach the principles of ecological balance by referring to forests, and as a transfer test ask what effect pollution will have on the population of a lake. We describe an experiment not presented in the text, and ask the student to discuss possible interpretations and needed controls. Any of these tests can be administered in a short time. But the more significant type of transfer may be the increased ability to learn in a particular field. There is very likely a considerable difference between the ability to draw conclusions from a neatly finished experiment, and the ability to tease insight out of the disordered and inconsistent observations that come with continuous laboratory work on a problem. The student who masters a good biology course may become better able to comprehend certain types of theory and data, so that he gains more from a subsequent year of study in ethnology; we do not measure this gain by testing his understanding of short passages in ethnology. There has rarely been an appraisal of ability to work through a problem situation or a complex body of knowledge over a period of days or months. Despite the practical difficulties that attend an attempt to measure the effect of a course on a person's subsequent learning, such "learning to learn" is so important that a serious effort should be made to detect such effects and to understand how they may be fostered.

The technique of programed instruction may be adapted to appraise learning ability. One might, for example, test the student's rate of mastery of a self contained, programed unit on heat, or some other topic not studied. If the program is truly self-contained every student can master it, but the one with greater scientific comprehension will hopefully make fewer errors and progress faster. The program might be prepared in several logically complete versions, ranging from one with very small "steps" to one with minimal internal redundancy, on the hypothesis that the better educated student could cope with the less redundant program. Moreover, he might prefer its greater elegance.

Conclusion

Old habits of thought and long-established techniques are poor guides to the evaluation required for course improvement. Traditionally, educational measurement has been chiefly concerned with producing fair and precise scores for comparing individuals. Educational experimentation has been concerned with comparing score averages of competing courses. But course evaluation calls for description of outcomes. This description should be made on the broadest possible scale, even at the sacrifice of superficial fairness and precision.

Course evaluation should ascertain what changes a course produces and should identify aspects of the course that need revision.

The outcomes observed should include general outcomes ranging far beyond the content of the curriculum itself: attitudes, career choices, general understandings and intellectual powers, and aptitude for further learning in the field. Analysis of performance on single items or types of problems is more informative than analysis of composite scores. It is not necessary or desirable to give the same test to all pupils; rather, as many questions as possible should be given, each to a different moderate-sized sample of pupils. Costly techniques such as interviews and essay tests can profitably be applied to samples of pupils, whereas testing everyone would be out of the question.

Asking the right questions about educational outcomes can do much to improve educational effectiveness. Even if the right data are collected, evaluation will have contributed too little if it only places a seal of approval on certain courses and casts others into disfavor. Evaluation is a fundamental part of curriculum development, not an appendage. Its job is to collect facts the course developer can and will use to do a better job, and facts from which a deeper understanding of the educational process will emerge.

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13

The Return to Learning

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The Curse of Obsolescence in the Schools can be Mitigated by the Scholars in the Universities

I

Today we are witnessing an advance in the quality of elementary- and secondary-school education in the United States that would have appeared almost impossible to achieve a decade or so ago. Although still affecting only a relatively small number of schools and teachers, this impressive move forward is already powerful and pervasive enough to be currently challenging the colleges to step up the quality and maturity of their undergraduate programs.

This paper seeks to identify some of the factors leading to this encouraging trend toward better teaching in our schools, and to provide an historical note on the Physical Science Study Committee and the movement it inspired. It is the story, especially, of how the scholars in the universities, by long indifference to education in the pre-college school and even in the undergraduate college, let obsolescence in learning creep through our educational system. Now they are reasserting their responsibilities for teaching at all levels and demonstrating anew that only the master scholar, working in association with the skilled teacher, can achieve that quality of relevance, up-to-dateness, and integrity that the education process urgently needs throughout its whole spectrum.

II

What is taking place can aptly be likened to a "renaissance movement." It combines a "return to learning" with the "enlightenment" of bold and imaginative ideas about the nature of the learning process. The movement not only marks the return of the university scholar and scientist to direct concern with the teaching of their subjects at all levels of the learning scale. It also marks a reawakening to the fact that children have a native eagerness to learn. Their inherent interest in the world about them responds wonderfully when it is adequately nurtured and encouraged and not blunted nor put off until later. And finally, like any important movement in history, this one was born out of cumulative dissatisfaction with trends of the recent past.

The first half of this century saw some remarkable achievements in American education. For one thing, its sheer growth—in all directions—and our adjustment to this growth was a majestic event in our history. This was the era in which we sought to extend our democratic ideal of universal public education beyond the elementary school level. This was also the period in which the graduate schools of our American universities grew into centers of eminence and excellence for scholarly and scientific research, with the best of them matching the best anywhere else in the world. It was still common even for graduates of my generation to proceed to the great European universities for their doctoral and post-doctoral work. But there has been a dramatic shift in the flow of travel since then, just as there has been a dramatic shift in the geography of Nobel prizes.

The achievement of excellence at the top, however, was paralleled by a gradual deterioration of excellence below. Scientists and scholars advancing the forefront of knowledge in their respective fields divorced themselves almost completely from what lay behind them—at the undergraduate level often, let alone at the lower levels of the teaching and learning scale, apparently unaware of the intellectual vacuum they were helping thereby to create.

At the same time the "progressive" movement, despite some of the good things it had brought to education, had come to a sterile end. In too many schools subject matter had been degraded and subordinated to "adjustment to life," achievement gave way to "orientation"; the notion thrived that education must not be offered to a child until he showed readiness for it, but that his social well-being demanded that he be moved forward into secondary school and college steadily, smoothly, and if necessary, ignorantly. In addition, the professional education courses, in which these notions had become entrenched into dogma, were attracting fewer and fewer of our more talented college and university students into the teaching profession.

While we were intent on getting our burgeoning school population educated, the number of able teachers was not keeping pace and quality was consequently dropping further behind. And as we entered the second half of the century, much of our American precollege educational system was threatened by obsolescence.

It is hard to say who first awoke to the fact that the obsolescence could lead to disaster. In part it was the parents who discovered that Johnny not only could not read but also might not get into the college of his—or their—choice. In part it was the college and university administrators faced with adding remedial reading and English composition courses to their curriculums as well as cramming into the last few years of Johnny's life as a student the vast amount of new contemporary knowledge he would need to fit him for professional life. In part it was the scientist who recognized how few of us are intellectually prepared for the national and international responsibilities we are endeavoring to take on in an age when science and technology are revolutionizing the lives of all of us.

By 1950 criticism and debate began to rise in all quarters, with the American people aroused as they never had been before to an interest in what their children were being taught and who was teaching it to them. The long indifference to teaching as a profession was over.

III

Some notably important events occurred in the early part of the decade of the 50's. One was the formation of the Fund for the Advancement of Education in 1951, with substantial grants from the Ford Foundation to finance innovation and experimentation. This significant infusion of risk capital into research and development in education has already produced some significant results. The most important one, perhaps, is the successful evolution and gradual acceptance of the so-called "fifth-year program," which is beginning to attract increasing numbers of non-mediocre college and university graduates into the teaching profession again.

This program does away with the professional courses in the undergraduate years that used to make up about half the required curriculum for prospective public school teachers, thus allowing them to get better "educated" there in the subject matter they propose to teach. In their graduate year they continue study in their subject specialty, get a firm grounding in basic education courses such as psychology, philosophy, and history, and begin their practical training as part-time paid "interns."

Interestingly enough, the fifth-year program grew out of one initially conceived and started at Harvard as a Master of Arts in Teaching Program by Dr. Conant in 1936. It attracted few applicants, however, until the revival of interest in better academic training for teachers began.

In 1952 Harvard's Graduate School of Education gained support from the Fund to revitalize its program with a recruitment and guidance officer located at each of 29 liberal-arts colleges and offering scholarship funds to interested potential candidates. At this time students entering the program were "apprenticed" without pay to get their practical training. By 1955, however, Harvard succeeded in introducing the "internship" concept, which provides for financial support from the participating schools.

With Fund support and encouragement, variations of the Harvard "model" soon spread to a number of other private and state universities with strong education departments of their own. Harvard, itself, expanded its program to include 42 cooperating liberal-arts colleges, currently has three times as many applicants as it had in 1952. By 1959, the Ford Foundation felt that the value of this new teacher-education pattern was sufficiently proven to warrant large grants for its more widespread adaptation and adoption. The Foundation has since made grants of $27.5 million involving 42 colleges and universities throughout the country and scores of participating school systems, to assist them both in revising and strengthening their teacher-training programs and in adapting their school organizations to introduce team teaching and other innovations that stem from it.

The conception of the teaching team as an incentive for recruiting superior talent, as well as a more efficient method of utilizing it, was first proposed in 1956 by Dean Francis Keppel of Harvard, now our U.S. Commissioner of Education. Essentially, it creates a hierarchy of job classifications ranging from team leader to clerical aide and a pay differential related to skill and responsibility. In addition to the incentive and efficiency features, however, it has other important implications for better teaching. It is an ideal device for supervised in-service training of new teachers; it forces teachers to plan jointly on the development of the school's curriculum and to benefit from each other's observations and experience; and it permits flexible groupings of students so that each proceeds more closely to his capabilities, and flexible scheduling of class periods and class sizes to fit particular instructional needs.

Just as the development of the fifth-year program is overthrowing our traditional pattern of educating our teachers, the introduction of the teaching team is bringing to an end our traditional, self-contained, one-teacher classroom with its rigid grade-to-average-ability stratification.

Assuring more qualified, better-educated teachers and creating a climate within our schools more favorable to better teaching and better learning are important contributions to the achievement of excellence in our education system, but they are only half the job. The other half—in many ways, the most difficult half—is to achieve intellectual excellence in what is being taught and learned. The movement for reform in that direction was slower in getting under way, but it has gained tremendous momentum in the past five years or so. It really became air-borne after a professor of physics at M.I.T. made a bold proposal in 1956.

IV

This story starts with a memorandum I received from Professor Jerrold Zacharias on March 15, 1956. Its subject was "Movie Aids for Teaching Physics in High Schools," but as the following excerpts show, Dr. Zacharias had more in mind than making movies to supplement existing physics courses:

> In an effort to improve the teaching of high school physics I want to propose an experiment involving the preparation of a large number of moving picture shorts . . . complete with text books, problem books, question cards and answer cards . . . but before taking up the detailed mechanism it is necessary first to look at the subject matter. Success or failure depends to a large extent on having the entire apparatus of the experiment really right. Like a high fidelity phonograph, one must have

> besides the machine a good piece by a good composer played by an artist. The room must be good, not too nosiy, and the people have to want to listen, but that all depends upon the piece.
>
> . . . The tidy notions of classical mechanics still predominate in the way we try to introduce the subject of physics and it usually happens that these notions are dull as presented because it is so difficult to present arresting experiments to liven them up. Because one needs to understand many of the basic ideas and mathematical methods before gaining a profound comprehension, it always seems logical to begin with the basic ideas of vectors, velocities, statics, hydrostatics, force, mass, etc. Now I think that physics can be divided up into the following parts: (1) the particles and the bodies, (2) between these bodies we have laws of force, (3) under the action of these forces the things move with the laws of motion . . .
>
> In any case the material to be presented is going to require imaginative but painstaking work. A summer study is probably the best way to get the outline and the beginnings of the text. Plans for the demonstrations could be laid out and perhaps arrangements could be made to have some things built and tested. Some sample films should be made to see whether we should alter the methods of the professional short subject shooters. . . .
>
> The financial side of such an enterprise becomes obvious. . . . But the efficiency of Flaubert was not high.

The memorandum, fortunately, evoked an encouraging response from the M.I.T. administration, and with its help Professor Zacharias was soon to secure assurances of support from the National Science Foundation, the Ford Foundation, and the Alfred P. Sloan Foundation. Now Dr. Zacharias had to convince other top-flight physicists of the importance of giving time and thought to this endeavor—to turn their attention to a different kind of research problem, if you will.

Recruiting and planning began in earnest in the summer of 1956, though the Physical Science Study Committee was not formally and officially launched until November of that year. Informal but intensive discussions were held periodically at M.I.T. all through the summer and fall among a "steering" group that included, besides Dr. Zacharias and myself, the late Professor Francis Friedman (who, before his death in 1962, contributed brilliantly to the whole program), and Professors Nathaniel Frank and Martin Deutsch of

M.I.T.'s physics department; Dr. Isador I. Rabi of Columbia and Dr. Edward M. Purcell of Harvard, both of them Nobel Laureates in physics; Dr. Henry Chauncy of Educational Testing Service; Dr. Edwin H. Land, founder-president of the Polaroid Corporation; Dr. Mervin Kelly, then president of Bell Telephone Laboratories; and Dr. Morris Meister, now president of Bronx Community College, but at that time principal of the Bronx High School of Science. Similar groups of interested scientists and teachers were generated—one centered at Bell Telephone Laboratories, another at Educational Testing Service, others at Bryn Mawr, Cornell, and the University of Illinois—and all were asked to begin shaping their ideas of how the new course should be developed and what it should contain, in preparation for meeting jointly for three days during the Christmas holiday in 1956.

The December meeting produced a good deal of heated argument among the fifty participants, but, nevertheless, agreement on basic conceptual goals emerged. The course should meet the highest standards of intellectual rigor. Much that is a part of physics might be omitted, but what was presented should be given the structure and taste that reflected the most advanced thinking. It should present physics as the contemporary physicist sees it—as the gradual unfolding of the nature of the universe by a continual process of inquiry, exploration, and discovery, and, as such, one of the most admirable achievements of the human mind and an indispensable part of Western thought and culture. The course should be designed to lead the student to this conception by letting him learn, insofar as possible, by exploring and experimenting as the scientist does.

It was also agreed at the outset that motion picture films, laboratory apparatus and experiments, texts, collateral reading, and examinations should all be complementary and integral parts of the whole, each medium of instruction being used to its best advantage to reinforce, not duplicate, the effectiveness of the others. Most importantly, those who attended this session could see, with Dr. Zacharias, that success depended on having the entire experiment "really right" and they were imbued with an enthusiasm and determination to make it really right. Their enthusiasm helped spread the gospel to others of their professional colleagues, and their determination was put to the test when the serious work began the following summer and went on almost unabatedly for everyone involved for the next three years.

First the physicists learned that they themselves had to deepen their understanding of physics, to gain a better comprehension of its principal concepts and their relation one with the other before they could put together a coherent story that would bring a measure of the same comprehension to the beginning student. Then they learned that transforming this story into hard reality of finished text, experiment, equipment and film demanded the same rigorous attention to excellence in writing, in designing experiments and equipment, in movie production. It also required successive testing, revising, testing again, sometimes even scrapping months of work on an experiment or a piece of text or a film that didn't get its point across with precision. And since their approach was so radically different from the conventional approach to teaching physics, they learned that their success depended not only on having the physics "really right" but on having it taught right. Teachers had to be taught how to use the course effectively, they had to understand why it was shaped as it was, they had to become familiar with the experimental equipment and other teaching aids and understand their complementary relationship to the content and purpose of the course. The summer institutes, sponsored and financed by the National Science Foundation in various universities across the country, have played an essential role in this teacher training.

The rewards for this diligent and sometimes arduous effort were great, particularly as some of the early teaching-trials showed that the course sparked the minds of even normally laggard students—as one of the teachers put it, he would certainly like to have it for the gifted students, he would henceforth *insist* on it for the slow ones. Gratification grew with the spread of the course into more and more schools and as more experience was gained in teaching it, for it had clearly caught the imagination of both teachers and students exposed to it.

By 1960, when the text was finally revised for hard-cover printing, it was being used by 1,100 teachers and 44,000 students. This year the course is being taught to 130,000 students, about 30 percent of those studying physics in United States high schools.

Thus far 53 PSSC films have been produced with many of the leading physicists in Canada and the United States playing the principal roles in demonstrating or explaining basic concepts. The Science Study Series, with some 40 titles so far published, provides collateral reading for science students. So far over a million copies have been sold in the United States and half a million abroad. PSSC materials have been translated into over a dozen languages, including Swedish, Italian, Japanese, Hebrew, Spanish, Portuguese, Danish, and Turkish.

V

Long before the PSSC course was finished, it was apparent that the experiment Dr. Zacharias had instigated was going to affect more than the teaching of physics in high schools.

For one thing, it almost immediately stimulated scientists in other fields to a similar interest in the way their subjects were, or were not, being taught in the schools. By the spring of 1958, before the first trials of parts of the PSSC course in eight schools were over, mathematicians, biologists, and chemists were assembling conferences to discuss curriculum reform. By the following year, many of these had reached the "summer study" phase.

The Physical Science Study Committee itself realized early that the course it was preparing would be neither perfect nor permanent nor an end unto itself. The course was predicated to a large extent on the nature of the American high school in 1956 and the generally low level of useful preparation in the sciences the beginning student in physics had received in his earlier school years. Certain essential concepts, such as statistical mechanics and special theory of relativity, considered too difficult at the time, had to be left out in favor of certain more elementary material—not beyond the comprehension of much younger students, as subsequent experiments teaching the first part of the course to junior high school students showed.

It was evident that if the quality of science preparation in the earlier years could be upgraded, there would be room for still more advanced work in the high school curriculum. There was also early indication that the teaching of undergraduate physics could be substantially revised for first-year science and engineering students entering college with the PSSC course behind them.

Furthermore, as teaching experience with the PSSC course revealed the latent capacity of almost all students to grasp even the toughest concepts of physics, it became possible to foresee that the approach the physicists had taken to the teaching and learning of their subject might be applicable to upgrading the subject structure of the entire education process.

Several of those closely associated with the physics-course project were beginning to think along these lines before PSSC was officially two years old. They could visualize an extension of its aims and purposes for many years, possibly permanently, beyond the completion of the immediate project. By then, too, it was spending nearly $1.5 million a year and involving the time and talents of several hundred people, though not all of them on a full-time basis. Business aspects of the project—negotiating and contracting for the production and distribution of books, films, and laboratory equipment; the continuing accumulation of paper work to be processed, such as requests for information and assistance, and the essential teachers' feedback of suggestions for revisions—were rapidly mounting and becoming more than the professors and science teachers that made up the committee were prepared to cope with, or even wanted to. The burden of supplying business services and management as well as much of the overhead for the committee's work fell on M.I.T. itself.

To meet this problem a new institution was needed, especially designed to serve as an administrative vehicle to handle PSSC and similar programs that were certain to evolve in the future. Accordingly, a non-profit corporation, patterned after ones that had recently been formed to serve the federal government (Institute for Defense Analyses and System Development Corporation, for example) was organized in August 1958 with the title, Educational Services Incorporated (ESI).

ESI promptly demonstrated that it filled an important need in American education. It has been called upon to handle many curriculum improvement projects—more, in fact, than it has been able to accept. Chief among its more than twenty present projects are (a) an Elementary Science Study in which more than a hundred scientists and educators from the United States and overseas are associated in the preparation of new material for the elementary grades; (b) a preliminary exploration of a new curriculum in social studies and humanities, which it sponsors jointly with the American Council of Learned Societies; and (c) an African Education Study, financed largely by the U.S. Agency for International Development. This latter project is designed to help transitional nations in tropical Africa meet their needs in the social studies and humanities as well as in mathematics, the sciences, and languages. This broad program is developing as a partnership between African educators and groups from the United Kingdom and the United States.

In addition to such pre-college programs as those noted above, ESI is carrying out programs for the following two college committees:

> The Semiconductor Electronics Education Committee, a group of 47 persons from eleven universities and eight industrial companies engaged in developing a one-year course on the principles and applications of semiconductors for junior or senior science and engineering students. The course makes integrated use of films and text and both formal laboratory experiments and those that can be done at home with specially designed take-home kits. It was used for the first time, in preliminary form, during the 1962–1963 academic year at 14 universities in the United States and Great Britain.
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> The National Committee for Fluid Mechanics Films, which is producing a series of films designed to illuminate various physical phenomena of fluid mechanics for students in several branches of engineering as well as those in meteorology, applied mathematics, and medicine. The two major films so far completed by this committee are currently being used at more than 60 universities in the United States and abroad.
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> One important feature of Educational Services Inc. is its film studio, which was established first to produce the PSSC films and is currently producing films for all the programs described above. The studio has also been commissioned by other curriculum-reform groups in the United States to produce films for their projects.

Thus Educational Services Inc. has grown into a major center for initiating and undertaking the development of new courses of study patterned on the successful pioneering approach of PSSC—assembling master scholars, scientists and teachers to create jointly a new excellence in education. In recognition of its important and growing role in curriculum research and development, the Ford Foundation has recently given ESI $1 million to provide necessary capital and to explore potential new avenues of endeavor before they reach the specific project-support phase.

In the area of curriculum improvement in the sciences—the disciplines which have pioneered the reform movement—the National Science Foundation has been the principal source of support. Since 1959 it has been making grants toward this end of over $6 million annually. It has supported over 130 individual projects ranging from mathematics for kindergarten children to solid mechanics for university graduate students, and in size from production of a single teaching film or a one-week curriculum study conference to full-scale "critical mass" efforts, like the PSSC physics course and those being prepared by the School Mathematics Study Group and Biological Sciences Curriculum Study, all of which have taken four to five years to complete at a cost of between $4 and $5 million. The National Science Foundation is also spending about $35 million a year for the all-important teacher-training institutes, to give both school and college teachers in the sciences better grounding in their subjects. Many of these institutes, as I have indicated, are now designed to train teachers in the new science courses being developed.

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I trust you can now begin to see why I believe we will achieve a vast improvement in quality in education in this country. I am encouraged in this belief by what has already been accomplished and the speed and scope the movement has gathered in the past few years. Although it has been estimated that the innovations so far cannot have reached more than 10 percent of the 47 million children enrolled in our elementary and secondary schools, the coming decade will most surely see a dramatic rise in that percentage.

I am also encouraged by the fundamental shift in attitude of the American people as a whole toward excellence in education and their growing acceptance of the idea that it is democratic to give special attention to gifted students. The introduction of enriched programs of study and advanced placement courses now in hundreds of our better high schools has already had a marked effect on the students that have been exposed to them. Several colleges and universities with high admittance standards are finding that their "best freshmen are getting better—getting better *fast*," as Lee DuBridge, President of Caltech, affirms in a recent issue of his institution's *Quarterly*. He notes "a rise of from 10 to as much as 40 points on the percentile scale [of CEEB test scores] for the average freshman in the past ten years" at universities such as Caltech, Harvard, Yale, Princeton, Stanford, and M.I.T. This is permitting substantial upgrading in courses offered entering freshmen and, in some cases, major modifications of the entire undergraduate curriculum, plus the welcome dropping of remedial English and other courses designed to make up for the deficiencies of pre-college preparation.

There has been a more significant finding, however, from our experience so far with programs introduced to encourage our most able students to their fullest capacities. We are learning that we have probably underestimated the abilities of nearly *all* our children. In reviewing the past decade of this experience, Elizabeth Paschal of the Fund for the Advancement of Education, concludes, "The unmistakable evidence both that the general level of education is improved when special programs for gifted students are initiated and that superior students as well as others benefit from basic changes in school practices in the use of resources and the acquisition of well-educated teachers underlines some important findings about the nature of intellectual giftedness and other talents. Schools which have established special programs are convinced that giftedness in general intellectual capacity or in some special talent is far more widespread than they had originally supposed and that a substantial proportion of the children in each school need specific provision for the full realization of their capacities."

And, finally, the most encouraging aspect of all is to see the spread of interest in teaching among our best university research scholars and scientists—their growing recognition that they can turn their attention to the teaching of their subjects at the pre-college and undergraduate levels without injuring the growth of excellence at the graduate level. As Philip Morrison, Professor of Physics at Cornell, has remarked: "Only when the universities recognize that all learning is partly their business, can a self-sustaining educational system not cursed by intrinsic obsolescence come into being." I believe we are well on our way toward achieving this for the first time in our history.

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The Curriculum and the Purposes of Education

STERLING M. MCMURRIN · UNIVERSITY OF UTAH

The future of American education depends in large degree upon the character of our efforts to define its aims and purposes, for without a clear conception of what the schools should achieve it is not possible to determine either the proper substance of education or its appropriate methods. Over the past few decades we have given much attention to the methods of education, and important advances have been made in both methodological theory and practice, but we have quite seriously neglected the problem of the ends of education and have at times thereby permitted the means to dominate the ends. This is not to suggest that the ends should be established independently of a consideration of the means necessary to their achievement, and certainly neither ends nor means can be fully discussed in indifference to the question of the substance or content of education, what it is that is to be taught and learned. We must work at all three together if the needs of the future are to be satisfied and our educational potential fully realized.

Any consideration of the specific aims of education must recognize that the schools have three primary objectives: to serve the individual and his purposes, contribute to the strength and order of society, and insure high achievement and vitality to the culture. This does not mean that there should in some way be three concurrent educational programs. In a democratic society education is properly directed to the individual, but the individual cannot be abstracted from his society or his culture. They are affected by him and he is in part at least a product of them. And it is basic to the faith of a democracy that whatever ministers to the well-being of the individual person will at the same time contribute to the total integrity of his society and improve the condition of his culture. Those who bear the responsibility for determining the character and content of the curricula of the schools have the large task of guaranteeing this coincidence of the functions and products of education. They can perform this task adequately only if they fully come to grips with both the long and short range purposes of education as these are defined against a background of competent knowledge. It must be a knowledge, of course, of human personality and human behavior and of the predicament of the individual person as he confronts the multiple and complex forces of modern industrial society, and this requires a thorough acquaintance with the condition of our society, its structure and processes. More than that, it requires an appreciation and understanding of the goals of society, of the ends which it has set for itself, of the purposes of the Nation both domestic and international. And quite certainly it demands a sensitive understanding of the value structure of the culture and some comprehension of the state of knowledge and of the arts and genuine insight into the character of the culture, its genius and its possibilities. This means, of course, that the discussion of the purposes of education must be a continuing effort that enlists the Nation's finest talent. It requires the cooperation of those who possess the requisite specialized knowledge, from education, the arts, science, and philosophy, and those from business, labor, government, and the professions whose broad and extensive experience endows them with practical wisdom.

Fortunately the growing national concern for the improvement of the quality of education is accompanied by an increasing willingness of persons of high ability and achievement to devote their energies and talents to the problems of the schools. Nothing in recent decades has done more to move American education in the direction of general excellence or holds greater promise for the future than the involvement of highly competent subject matter specialists in the improvement of secondary course materials and in the education of teachers. The engagement of scientists of national and international reputation in the tasks of especially secondary but also elementary education has established a movement that is already spreading to the social studies and the humanities and arts and that must inevitably have major consequences for the whole intellectual life of our people. The high level cooperative work that is now being done in the upgrading and updating of course materials for the schools should serve as an example in the effort to determine the large ends to which education should be devoted.

The current effort to raise the level of the intellectual accomplishment of the schools promises to be eminently successful, but it has encountered strong resistance from certain attitudes and habits of thought that are firmly established in the American mind. To the extent that the raising of academic standards and a more adequate exploitation of the intellectual capabilities of students have required a recognition of individual differences in ability, interest, or motivation, they have at times confronted the stubborn opposition of the egalitarian ideal that has been traditional with our people. That ideal has had an essentially political basis and has served the country well in the extension of political freedom and in establishing equality before the law. And it has had important consequences for education, for it has been basic in the movement toward universal education and has inspired the development of the public school movement. It has long been recognized, however, that our concern for the principle of equality, which is the foundation of so much that is precious to us, can be a source of mediocrity when it becomes an inordinate commitment that refuses to recognize the large differences that obtain among individuals. That every person is of absolute intrinsic value and therefore of equal worth with every other, and that our social philosophy and practice should be founded upon that equality of worth do not justify indifference to the variety and diversity of intellectual and artistic endowments that distinguish persons from one another and are, indeed, essential to their full individuality. Our native passion for equality and our abhorrence of all forms of aristocracy have contributed importantly to the large measure of standardization in education and techniques that has so often inclined the efforts of the schools toward average achievement and resulted in something far short of excellence if not in complete mediocrity.

There has always been, of course, resistance to the conformity that both ignores and destroys differences, and now with both educators and large segments of the general public aroused to an increased consciousness of the worth and importance and, indeed, the desperate necessity of the highest educational achievement of which our society is capable, the meaning of equality in relation to educational policy is being reexamined. Certainly there is a growing recognition that an enforced or induced conformity can destroy much that is precious in human personality and that our basic commitment to the worth of the individual person demands that we not only regard his differences and even his eccentricities, but that we honor them in our educational policies and procedures. Otherwise we are guilty of denying to him a very basic freedom, the freedom to be himself, to cultivate his talents, abilities, and skills by the genious of his own personality. We are guilty, indeed, of in a sense partially depriving him of his personality.

Moreover, it is now more clearly seen that the recognition, protection, and cultivation of individual differences are essential to the character of our society and the quality of our culture. For the very meaning and value of a democratic society entail a genuine diversity —a diversity of attitudes, ways of thinking and ways of doing things that guarantees the full competition of ideas and the pluralistic structure of institutional life. It is only within such a context that an authentic individualism can be achieved and, reciprocally, it is only on the ground of a sincere individualism that a democratic society can be constructed. And it is now entirely clear that the initiative, inventiveness, and creativity that are essential to the full development of our Nation's intellectual capability, in the extension of all forms of knowledge and in the cultivation of that artistic sensitivity and critical intelligence necessary to a culture of high refinement and to practical success in the pursuit of the material ends of society, depend upon the achievement of a genuine and viable individualism.

There is a sense in which a true individualism issues from a proper relationship of freedom and equality in both theory and practice. We should heed the warning of that perceptive observer of American life and institutions, Alexis de Tocqueville, who more than a century ago wrote, "I think that democratic communities have a natural taste for freedom; left to themselves, they will seek it, cherish it, and view any privation of it with regret. But for equality, their passion is ardent, insatiable, incessant, invincible; they call for equality in freedom, and, if they cannot obtain that, they still call for equality in slavery. They will endure poverty, servitude, barbarism; but they will not endure aristocracy." Our ideal, clearly, is to avoid both aristocracy in society and the servitude of the individual. It is to achieve a genuine freedom of the individual that is at the same time an equality with all others in intrinsic worth and in those opportunities that depend upon the decisions and actions of society.

But to recognize the importance and value of educational policies and procedures that properly discern disparities and nourish differences and fulfill individual potentialities is in itself no guarantee that these ends will be accomplished. The tasks of education are very difficult, far more difficult than the general public appreciates. And a differential type of education is costly, costly in talent and energy, and not simply in the talent and energy expended in the classroom and the laboratory, but of the home and the community as well—and in money. It is so much easier, and cheaper, to train rather than educate, train through those standardized formulas that get the job done effectively and efficiently and produce conformity and a dead leveling mediocrity. With all our respect for the worth of education, we cannot be sure that our society's commitment of its human and material resources to the tasks of the schools will be adequate to satisfy our rapidly expanding need for highly developed intelligence, skill, and creative talent.

In addition to resistance from the traditional egalitarianism, the attempt to improve the quality of education is up against a quite persistent anti-intellectualism that has for a long time infected the American mind and been one of the more obvious characteristics of American life and temperament. Here again the problem is not simply the task of changing the schools. The criticism of American education is properly not so much a criticism of the schools as of the society and culture generally. For the most part, our schools have reflected those facets of our culture that are deep and abiding, and they have accordingly provided the kind of education that has been expected or demanded of them. Their chief deficiencies have perhaps been their failure to more often affect the character of the culture rather than simply to be a function of it. At any rate, the anti-intellectualism from which we suffer has been all too commonly found even in our schools and has seriously affected the general character of our educational philosophy, and therefore the quality of our educational program.

The term "anti-intellectualism" covers a multitude of sins, and suffers therefore from inexactness and ambiguity. But it refers here at least to our all too common subordination of thought to practice, of intelligent effort to instinctive behavior, and of knowledge to action. It is our failure to value knowledge for its own sake as well as for its uses, to fully respect reason and evidence; it is our willingness to be controlled by passion and emotion and by hearsay and propaganda rather than to make our decisions and determine our actions by the more sure devices of knowledge and disciplined intelligence.

Our anti-intellectualistic tendencies are associated with our native practicalism and activism that are somewhat suspicious of theory and abstract thought but both of which account for much of our national vitality and achievement. But they result also from a kind of indifference and lethargy that restrain us from that degree of mental discipline and commitment to knowledge that are now so clearly among our greatest needs and that have such extensive implications for us as individuals and for the total life of our society, implications relating to both our national security and the moral, intellectual, and spiritual quality of our culture.

In conformity to the general national disposition and temper, our schools have all too often removed knowledge and the cultivation of the intellect from the center of their purposes and activities and have sometimes voluntarily, though often under intense social pressure, expended their resources and energies on pursuits that are of secondary and lesser value and are not the primary work of schools. Wherever one looks today he sees encouraging signs in education. Things generally are moving in good directions. And the most important of all is that the concern for the intellectual life is moving back into the center of the schools' interests and commitments. The faster the better.

Because of deficiencies and failures elsewhere among our social institutions, we have often saddled the schools with responsibilities quite unrelated to their primary purposes. But to say this does not mean that knowledge is the only concern appropriate to a school. We properly expect the schools to not only disseminate knowledge and to discipline the intellect but as well to bring refinement to the individual's aesthetic perception and his moral sensitivities, to cultivate his sense of civic responsibility and to nourish in him that appreciation and discernment of value necessary to a meaningful, purposeful life. But the total task of education belongs to the totality of society and is shared by its many institutions, each of which makes its contributions in accordance with its established function in the large complex of social affairs. The task of the school is a specialized one. Unless a school fastens its attention first upon knowledge and the cultivation of the intellect, it will do little for the moral character or spiritual or artistic life of either the individual or society. It will fail the individual and society in their need for both knowledge and the instruments of creative and critical thought, and will certainly fail to produce the practical wisdom requisite for high personal morality and a just social order.

To insist that knowledge should be placed firmly at the center of the school's function and kept there is not to recommend, as some seem to suppose, that we expend our energies on trivial information. Indeed, it is not primarily a matter of information at all, as important as certain kinds of information are. It is a matter of the full development of a person's intellectual equipment, a development that comes only through the serious pursuit of knowledge. It is experience in the analytical, constructive and critical uses of reason, in the generalizing and abstractive function of the mind, in grasping the relationship of parts to wholes and of the particular to the general and universal. It is a matter not simply of knowledge alone, but of the nature of theory, its construction and validation, and of tests for the reliability of knowledge. It is the cultivation of respect for evidence, of the recognition of fallacious argument, and of a sense of the relationships that obtain between theory and practice. It is refinement in perception and in the artistic sensitivities that are essential to creative thought. Above all, perhaps, it is a kind of initiation in the joys of knowing, in the worth of knowledge, and in the love of truth. Where something like this commands the principal intention and energies of a school, the way at least is open for the student to not only come into possession of reliable knowledge of the world and of its affairs, but to assess its problems intelligently and to come to grips with his own relationship to them. And it sets as well the framework within which he can best pursue his artistic interests, discipline his emotions and passions, make enlightened moral decisions, and construct meaningful interpretations of life and its experiences. With the signs of irrationalism in our society daily increasing in both world and domestic affairs, in politics, business, and religion, and with the future in grave danger and threatened by impulsive decision and action motivated by emotion and passion, the schools must make of themselves citadels of intellectual honesty and freedom and strongholds of knowledge and reason. Where they do less than this they may well contribute in various ways to the lives of their students and their communities, but they will not fulfill the measure of their purposes and responsibilities as schools.

The common segmentation of education generally impairs its quality and at times produces quite serious distortions in its character. The disjunction of college and secondary education especially, a condition for which educators themselves deserve to suffer not a little embarrassment and censure, often radically disrupts what should be a continuum that would give integrity and a unity of purpose to formal education. This is not to say that every child or youth should be marked for a college or university, for the practical needs of society in relation to the abilities and dispositions of the people will inevitably determine much of the constitution and character of the educational program. The entire area of advanced vocational and technical education deserves more attention and more esteem than it has ordinarily enjoyed. In the years ahead those vocational institutions especially that are geared to the advancements of science and industrial technology will play an increasingly important role in the Nation's economy. But the point is that a kind of organic unity should tie the schools together, higher-lower-technical, to secure for every person the finest education of which he is capable and to insure that in every school of whatever kind the student encounters at least a minimum of that liberal intellectual experience and knowledge and learning that should be the right of every civilized person. Every person, whatever his talents and whatever his ambitions, should be brought face to face with creative thought, with basic and profound ideas, with music and poetry; he should be exposed to them, and should have his chance to become infected by them.

It is becoming increasingly apparent that children can learn faster and at an earlier age than has been commonly supposed and the question of whether and to what extent the curriculum and even the organization of education should be restructured to more adequately conform to these abilities is now a quite serious one. It is entirely clear that the generality of the Nation's schools have failed to establish that intellectual strenuousness and enthusiasm in their classrooms and laboratories of which they should have been capable. This is not primarily a question of the quantity of work, as many seem to suppose, but rather of its quality. To increase quantity is the simplest of tasks, but to improve the quality of education is exceedingly difficult, difficult especially because it depends so heavily on the teachers, on their intellectual competencies. Without question there should be and will be considerable overhauling of subject matter and this should in various ways improve the quality of education at all levels. Much that is now taught in many colleges and universities, considered in terms of both its nature and level of difficulty, should be in the secondary schools, and much that is now found in the lower grades of the secondary schools would be more appropriate in the upper elementary grades. This is not a question simply of getting at things early as an acceleration or time saving device. It is more a matter of strengthening education by providing the students an intellectual diet more challenging to their capacities and of fashioning an educational program that combines economy with a more careful discrimination of subjects and their relationships.

But there is real danger of effecting changes simply on quantitative grounds or of failing utterly to sense the obvious but easily overlooked point that the simple fact that a fifth grade class can handle the principles of symbolic logic, for instance, is not in itself an argument that the Nation's elementary schools should settle down to logic. It may or may not be a good thing and the decision calls for great wisdom. An intelligent decision requires the knowledge gained from extensive and reliable research, but it also requires much wisdom, the wisdom that comes from large experience both in and out of education.

The basic principle that must be respected, and that is clearly in danger of serious violation, is that a child is not a man in miniature and the educational program, however much it must prepare him for adult life, should respect his childhood, and should respect the adolescence of youth, just as it respects the maturity of adults. Childhood is characterized by a creative initiative and imaginativeness, for instance, that must be protected and nourished for their own sake, that is for the sake of the child as a child, as well as for the total intellectual life of the child becoming a man. Adolescence has its native properties, and these also must be honored. So here is a very large problem. The effort to avoid treating adults as adolescents and adolescents as children could result in treating children as adolescents and adolescents as adults.

It is perhaps impossible to estimate the practical value of research in education. Much of the work done in recent years has been trivial in character and of little value. But quite certainly much of it has been of very great worth and has clearly demonstrated the advisability of enlarging the research program across the Nation. The present investment in educational research is so miserably small as to be almost negligible in comparison with the investment in industrial, commercial, and technological research. It is a field that is learning rapidly from its own mistakes and which holds great promise for the future. In the decades ahead the character of education will depend very heavily on the quality of the work done by research scholars working individually and in teams on the basic problems of education ranging all the way from learning theory to the large cultural purposes of the schools. Apart from the fact that too often the results of competent research are not effectively communicated to the profession at large and that there are too few arrangements for adequately testing new ideas in the classroom or laboratory, perhaps the main deficiency of the current research effort is that its base is established too exclusively in terms of psychological problems and its concern is somewhat limited, having to do especially with methodological issues. Here again, however, things are moving in a good direction, with an increase of interest in education from such fields as sociology, anthropology, and philosophy, and with a growing interest in upgrading the substance of the established basic courses. The curriculum studies that have been directed to this latter end have engaged the joint effort of education experts and highly competent scientists and scholars with very satisfying results and we may expect much more of this kind of cooperative work in the future.

There has been and no doubt still is some fear among those in educational research that the now well-established program of directed work on course materials might seriously endanger the enterprise of non-directed research, where the problems are identified freely in terms of the interests and talents of the individual research scholar or team and the projects are funded, from either private or public resources, simply on the basis of their merit as promising producers of new knowledge. There would seem to be, however, a genuine need for both kinds of activity, the non-directed research that is the best guarantee of a wealth of basic reliable knowledge relevant to education, and directed developmental work intended to apply that knowledge effectively in the large practical tasks of education. Education in itself is not a science; it is an art. Educational research, therefore, has as its proper end not simply the getting of knowledge for the sake of having it, but rather for the sake of its practical uses, and to stop short of an effort to employ the knowledge gained from research in the actual process of education is to entirely miss the point. It may be appropriate for a particular research scholar to ignore the practical uses of the results of his research, but to have value for education, that knowledge must somewhere figure in the actual processes of education.

To sense the importance of the new curriculum studies one need only compare them to the old style textbook writing. Traditionally secondary school texts have been the product of one or two or, in unusual cases, three persons, usually secondary teachers with an occasional college instructor, sometimes genuinely competent but often quite unacquainted with the latest developments in the field. Their work unfortunately was too often a rehashing of old stuff done up with a little window dressing but essentially in the old format. Today the major studies—in physics, chemistry, biology, mathematics, languages, and English—engage some of the best brains and most celebrated talent in the Nation, scholars, scientists, teachers and education experts of the highest order, working in teams, exploiting not only their own but the resources of their institutions and of whole school districts, to create teaching materials—texts, collateral readings, experimental equipment, and visual and audial aids—that are of a quality and usefulness that could not have been produced with lesser talent and small outlays of money, time, and energy. The materials produced by the major curriculum study groups are more than likely the product of hundreds of specialists and are thoroughly and systematically tried and tested in the process of preparation.

Today's high school student can learn his science from materials prepared in part through the efforts and under the direction of Nobel prize winners; tomorrow he will study English and the social sciences with materials resulting from the most extensive studies of leading scholars, teachers, and writers. Many schools are dragging their feet in their failure to recognize the value of this development, and many will continue to drag them. But a new day has dawned in American education and the quality of the schools in the future must inevitably be higher than in the past if we judge quality in terms of the heights that will be achieved in knowledge and intellectual development. And this refers not simply to the students of especially high intellectual endowment, but to the generality of students at all levels of education.

It is probably fair to say that by and large secondary education has been the weakest area in the education continuum. Its weakness has been especially its too common failure to adequately induct the student into the foundations of knowledge and to rigorously discipline his intellect and to cultivate his wonder and his intellectual curiosity and incite in him that adventurous quest for truth that is the crowning achievement of a school. It is entirely appropriate, therefore, that the large concentration of effort directed to these ends should have centered especially on the program of the secondary schools. But this does not mean that either the elementary schools or the instiutions of higher learning should be neglected. Much can and must be done to improve the curricula of the colleges and universities, and much is being done. It is perhaps safe to say that most of the colleges and universities of the Nation are conducting extensive critical analyses of their curricula and total educational programs. In some cases the practical results of these studies are quite radical, involving major policy changes affecting both the structure and content of the curriculum. Most colleges and universities can well afford a major housecleaning that would get rid of a great deal of academic rubbish and trivia and save time and energy that are now wasted. How to effect needed changes and at the same time preserve the large measure of faculty independence that is important to the character of a university educational program is a problem of considerable proportions.

Already, of course, many of the same breed of those who are working with the secondary curriculum, and indeed some of the same individuals, are giving serious attention to elementary education. Here the problems encountered are often different in character, but there can be little doubt that a general upgrading of the quality of elementary work will be the eventual outcome. Perhaps as much as anything else there is a need for a conception of elementary education that is one with the conception of the nature and purposes of education as a whole, so that while the childhood of the child is not violated, the centrality in the curriculum of genuinely intellectual pursuits is guaranteed. And this means the centrality of knowledge, important knowledge, in the broad and liberal sense. The mind is not disciplined nor are the intellectual skills and creative talents cultivated in some kind of vacuum that provides no object and no focus of interest and effort.

The large cost in money and talent of the new type massive attack curriculum and course content studies means that ordinarily they must be financed on a regional or national basis, by either foundation or public funds, and must draw their leadership and talent from the Nation at large. Few if any of even our largest communities and only a very few of the states could successfully mount programs of this type. Although it is to be hoped that more support will be forthcoming from private sources, thus far most of the major projects have been financed by the federal government through the United States Office of Education and the National Science Foundation. The large questions of federal aid to education and the control of education by the federal government must be faced, therefore, in any justification of this type of activity.

Most discussions of federal aid to education, both pro and con, are shot through with political interest and with emotion and even passion. That there are various kinds of federal financial investment in education is commonly disregarded in the heat of loose and generalized argument. In particular the distinction between general aid and categorical or special purpose aid is often overlooked by the public, and the various types of special aid are rarely discriminated, even by those who give serious attention to the subject. No general aid or "no strings attached" bill has ever been enacted into law by the Congress, but federal investments in education directed to special purposes have been made since before the signing of the Constitution. Today these funds, which include monies for various kinds of federally sponsored scientific research, total approximately three billion dollars a year. The justification for federal financing of the large curriculum improvement projects lies not alone in the large outlay of funds necessary to their success, but also in the fact that every community in the Nation, from the largest to the smallest, will profit from them. It would not be good economy, financial or otherwise, to default at the point of concerted national effort in the vain hope that the job would be done through local initiative and enterprise.

The question of the possibility of federal control of education, of course, is a matter of great importance. The monolithic structuring of the educational establishment and its program through any centralized authority or power, public or private, could seriously impair the quality of our culture through the decline of the pluralistic character of our intellectual life. But the federal government has funded a large variety of educational enterprises over a period of many years in amounts now totaling many of billions of dollars and the fears of those who anticipate federal dictation have not been justified. It is quite true that the government must establish certain kinds of controls over monies appropriated for education purposes. But these are fiscal and administrative controls intended to guarantee that the funds will actually be expended for the purposes for which they were appropriated and to insure that the funded projects are in the hands of persons of high competence. The curriculum studies financed by the National Science Foundation and the Office of Education are notable examples. The developmental and research work is directed and conducted by persons outside the government, experts drawn from the schools and universities. There are no government controls intended to determine the content or outcome of the studies. Some administrative decisions must be made by government officials but even here there is usually a generous use of advisory committees and panels whose membership is drawn from outside the government and represents both general and specialized competence appropriate to the task at hand. All in all, the effort to establish an atmosphere and context conducive to the best possible work and free from undesirable government influences has been highly successful in these programs. This is not to say that there are not important and difficult problems in this matter, but they are problems that can be and are worked through successfully.

It is legitimate to raise the question whether, quite independently of any intention or purpose of the sponsoring agencies, public or private, the development of course materials under some kind of formal organization of nationally recognized scholars and the effective dissemination of those materials will not pre-empt the field and in a sense establish intellectual monopolies that would result in the very monolithic structuring of the educational program that a democratic society must avoid. Now of course no one would advocate that a school or school district isolate itself intellectually and attempt to go it alone in such a matter as the development of the curriculum or the preparation of teaching materials. This would produce an utter confusion and hopelessness. No one objects to a school's looking beyond state boundaries when it is selecting a textbook, or learning from the practices of other institutions, near and far. The necessity for drawing from the product and experience of the entire Nation is taken for granted. Today, with a growing recognition of the importance of education for the achievement of national goals, goals relating especially to national survival and the protection and extension of freedom, and with the rapid expansion of knowledge and the demand for high level intellectual skills, there is an increase in statewide and regional educational planning and a growing concern for the achievement of large national perspectives in education, its responsibilities, possibilities, and needs. And there is a growing demand for national action for the satisfaction of those needs and the fulfillment of the best possibilities of our schools. National agencies both public and private are engaged in a multitude of educational activities extending from the reconstruction of vocational education for its better service to a highly technological society to the testing of individuals in ability and achievement and their measurement against national norms, and the study of the meaning of freedom and the responsibility of the schools to teach its fundamental principles. There is every reason to believe that in the decades ahead such activities on the national level will increase rather than decrease.

Now the question is, to what extent can the problems of education be pursued on a national scale involving national agencies and action without endangering whatever is of basic value in the decentralized structure of American education. Is the pluralistic character of education threatened by such large scale action and by the influence of national agencies and the use of nationally prepared materials? There are no legal controls on the schools requiring that they adopt a particular program or employ a particular set of teaching instruments. Aside from constitutional prohibition such as that relating to the establishment of religion, for the public schools, at least, there is no authority beyond the confines of any state that can make any requirements on what is to be taught in the schools of that state. Yet is it possible that the very existence of teaching materials prepared by nationally organized teams of the highest level ability will have a coercive impact upon the schools in determining their curricula and the content of their courses of study?

The impact will obviously be very great, and in some instances it already is, but this in itself does not mean that local independence and institutional freedom have been lost. When the typical school in the past has been under the necessity of employing nationally marketed teaching literature prepared by persons having no connection with the school's own program, there have been no responsible complaints that this robbed it of its independence or imposed unwarranted controls upon it. It has been taken for granted that the school boards, which have the final decision in such matters, are capable of making their decisions wisely and justly and are not the victims of pressure and intrigue. The main difference between the old pattern and that set by the new curriculum and course studies is that the very quality of the new materials recommends them so highly to those educators and school boards that have an honest interest in upgrading the work of their schools. This, of course, might have drastic consequences in some instances. It might lead to the consolidation of some small high schools to enable the appointment of physics or language teachers or the construction of science laboratories. And there no doubt are places where such moves would meet with opposition and the cry of unwarranted national influence of federal control. But fortunately such places are becoming fewer and farther between as the public raises its sights on both the responsibilities and possibilities of its educational institutions.

It should be made entirely clear that the agencies that have funded the large curriculum studies have no interest in the control of the schools or in the establishment of a single standardized educational program for the Nation. Already, of course, there is a large measure of standardization in the curriculum—English, history, biology, etc.—though it is by no means frozen or inflexible, and the curriculum studies are following along more or less conventional lines as far as subject areas are concerned. But the National Science Foundation and the United States Office of Education, whose activities in this area are very large, have no interest in establishing a single course in high school English for the entire Nation, or physics, chemistry, biology, or the several modern languages. They have no desire to destroy the competition among texts, for instance, by producing one or more for each course that will drive all competitors from the field. What they desire is to raise such materials to the highest level of educational merit when judged in terms of the purposes of education, the abilities of the students, the effectiveness of teaching techniques, and especially the state of knowledge. Certainly the same is true of the private organizations and foundations that are contributing to the curriculum studies. Neither they nor the scholars and scientists engaged in the actual work are seeking a monolithic educational program that is robbed of variety and diversity and is in danger of becoming fixed and frozen. They hope by their large-scale efforts to show what kind of thing can and should be done and to thereby stimulate new initiative and new creative effort on a higher level than has been traditional and typical. They are not attempting to establish some kind of educational monopoly. They want rather to engender a new and vital competition among materials and ideas that are up to date as far as the state of knowledge is concerned, and will provide the students full opportunity for intellectual growth. There is no absolutely best way of teaching a subject, or best textbook, or best anything else in education. Even if there were, there would be no sure way of identifying it. The whole matter must be kept open and viable. There is great value in diversity, especially the diversity that stimulates competition and keeps things moving in new and better directions. The problems of education will never be finally solved, and the pursuit of better ways of teaching and more valuable things to teach must never end. No project on the improvement of education, however successful or however widely accepted, should be regarded as definitive and final, as if the task were finished. The present curriculum studies are the beginning, not the end, of a more effective way of getting at the problem of the substance of education. They define the problem and in a sense describe a means to its solution that deserves continuing exploitation and improvement.

This does not mean that from here on there must be a continuing series of "massive attacks." A major and decisive breakthrough is now being made in some subjects and in something like the same way it must be made in those others that are basic in the educational program. But it would be unwise to develop a standardized format for curriculum study. The continuing work of the future should employ a variety of approaches and techniques. These may involve fewer persons and smaller outlays of money, for they will have the large advantage of the experience and results of the initial massive programs. Certainly there must be no return to the old rut of depending upon texts and materials prepared by persons of less than the finest competence which our society can provide. There will always be new knowledge, new and better ways of structuring and interpreting old knowledge, new insights into the effective uses of experiment and teaching equipment, and new understandings of the learning process and of the thresholds and limits of student talent and ability. And there should always be an increasing discernment of the proper ends of education that will enable educators and laymen alike to plan the curriculum to better purpose. It can only be hoped that the enthusiasm for the improvement of education that has widely infected society in very recent years will have a kind of lasting contagion and that the attitude of cooperation among professional educators and scholars and scientists that now prevails will become habitual.

Some have objected to the federal government's funding of secondary course content studies on the ground that for the Congress to appropriate monies for such purposes is not only unwarranted and dangerous federal interference with education, which is a state and local responsibility, but is vicious also on a second score, the interference of a legislature in the content of education, a responsibility properly belonging to legally designated educational authorities. But for the Congress to provide funds simply for the improvement of the teaching of the sciences or languages, where it makes no pronouncement whatsoever on what is to be taught, is hardly a case of dictating the educational program or interfering with the work of established officials. It is one thing to provide funds for the improvement of the teaching of biology or economics, subjects that by common assent are already recognized as belonging in the educational program. It would be quite another matter for the Congress to specify what biological theories or economic theories are to be taught.

Another charge, one which has been made by many school administrators, would seem on the surface at least to have more merit; that by providing funds for the improvement of teaching in certain fields, as for instance the sciences, the Congress has contributed to the development of serious imbalances or potential imbalances in the educational program. This, of course, is entirely true. That the total effect to date of the activities of the National Science Foundation and of the National Defense Education Act administered by the Office of Education has been a disproportionate emphasis on natural science is clearly evident. The justification for this, of course, has to do with the importance of technology in the matter of national security, but the problem created, nevertheless, is a serious one. But where some argue that therefore such appropriations should cease, the proper solution would seem to lie in just the opposite direction. In the first place, speaking in general terms, most would agree that it would be more desirable to have physics taught well and sociology taught poorly than to have both of them taught poorly. The solution, however, is to have neither of them taught poorly—to do for the teaching of sociology what in principle has been done for physics. There are, after all, only a very few established secondary school subjects, and already large-scale work has been done or is in process on not less than half of them. There is no good reason for not doing the job for the others. The imbalance in favor of science, a situation which poses a serious threat to the integrity of our culture, is to be overcome only by a commensurate investment of expert competence in the social studies and the humanities and arts.

The upgrading of the educational program of the schools is a complex task, certainly involving much more than the improvement of course materials. It means the improvement of the teacher's education, especially in his subject. And this requires the Nation's education schools to continue to move ahead along their present path of strengthening the entire teacher education program. Often it means that the already established teacher must return to school. It is no fault of his that his physics is outdated, for instance. There is a good chance that he learned an outdated classical physics in the first place, and certainly under the conditions that the average secondary school teacher works he has little opportunity to keep up with the rapid advances of his science. A large percentage of the teachers must return to the university for some solid work to insure their competence to do justice to the new improved materials that are available to the schools desiring to use them. It is this need which makes the federally financed development programs so valuable to the schools, for in mathematics, the natural sciences, and modern languages they now provide full-year academic institutes, summer institutes, and in-service institutes for the education of teachers who can qualify. And qualification, which is determined largely in terms of their educational needs and their responsibilities as teachers, means fellowships and subsistence monies without which such reschooling would in most cases be quite impossible. The response of teachers in seeking such reschooling and of school administrators in granting them leaves to enable their study in year institutes has been most encouraging, as has been also the quality of the work offered by the colleges and universities where the institutes are established. The extension of the institute program to more fields is one of the larger needs that deserves and is receiving consideration by the Congress.

The program in modern languages funded by the Office of Education under the National Defense Education Act of 1958 is especially valuable, as it involves research and development activities relating to the teaching of uncommon languages, matching funds for the acquisition by the schools of language laboratories, teachers' institutes for the improvement of teaching competence, and matching funds for university centers for the advanced study of certain important languages and of the cultures associated with those languages. The impact of all of this upon American education is already enormous, as exhibited in both the quantity and the quality of learning in the languages, and in the future its importance for the character of American culture as well as for the practical life of the Nation will become increasingly evident.

The problem of the curriculum is not simply the task of upgrading the content of the established courses. It is also the task of determining the general character and structure of the total educational program in terms of the purposes of education and the basic responsibilities of the schools. As indicated earlier, those purposes and responsibilities refer to the individual primarily, but also and importantly to society and the culture. They will be served only to the degree that the educative process contributes to the realization of a more genuine and viable individualism, where the individual is nourished in his differences and in his freedoms, and where those qualities of life that are truly personal are protected against the overwhelming impersonal and depersonalizing forces that would otherwise transform American society into a vast technocratic wasteland, dominated by mechanics and automation and overburdened with administration, and from which the sense of meaning and purpose would have disappeared and where the very enthusiasm of life would have vanished.

The culture must be in some way invested with a new vitality, a vitality that springs from the creative powers of the individual and is nurtured by the freedom of thought and action and expression that must be guaranteed not only by law and by the political institutions and the economy, but as well by the reasonableness of the people and by their sensitivity to whatever is authentic and precious in the meaning and fact of personality and freedom. The future depends immediately on the quality of statesmanship, on technology, military preparedness, and economic and political strength, those factors that make the difference in the material strength of the Nation as it faces the contest for its security and its very survival. But the real future, that stretches out far ahead and is precarious with unknown dangers and must always lie under the ominous threat of total extinction, the future in which both personal and corporate character could deteriorate under the oppression of the anxiety of annihilation, and which could well be a genuine decline of the culture and the disintegration of the basic institutions of society, does not depend alone on technology, industry, and the economy. It depends on whatever brings strength to the intellectual life of the people and to their artistic objectification of their affections, emotions, and passions. It depends upon their love of knowledge for its own sake as well as for its uses, their devotion to truth and to the ideal of reasonableness, and upon their perception of moral value, the sensitivities of their individual and collective conscience, and upon also their capacities to invest life with a profound meaning and purpose.

The task in curriculum planning that now faces the educators of the Nation is the task of meeting these large issues relating to the total life of the individual and the culture and to meet them in the presence of the powerful forces that are threatening to reduce education to the service of technology. Already serious imbalances are appearing in the program of higher education, imbalances that could eventuate in major distortions of the culture. That the lower schools could be affected in the same way should be entirely obvious. It would be a profound irony if those very actions taken by society to insure the strength of the Nation for survival were to contribute to a general deterioration of the culture and the quality of life of the people because of distortions in the educational program resulting from its too exclusive scientific and technological orientation. Yet something like this would seem to be entirely possible, and its prospect should excite the concern of all who are responsible for fashioning the curriculum at all levels of formal education.

This means especially that the place in education of the natural sciences, the humane studies, and the arts must be taken with the greatest seriousness. Clearly there is need for more, not less, science, and for an always advancing technology. This is not a time to become afraid of knowledge and its practical employment. But knowledge should be valued for its own sake as well as for its uses, and already there are dangers even to technology from the too small investment in basic science. It is a matter of the gravest import, however, that at the time of its greatest need there is too little knowledge of human beings, of human motivations, of social behavior, and of the causes and effects of those large forces that affect the character of a society and determine the course of history. There is a lack of understanding of man, his problems, and of the possibilities of their solution. There is a neglect in the pursuit of the arts, those objectifications of the human affections, emotions, and passions that express the inner and deeper life of man and bring refinement to his sentiments and his actions. And morality, sensitivity in the discrimination of right and wrong, and the capacity of decision and commitment, and indeed the whole life of the spirit in its quest for value and meaning are in danger of severe neglect from the threatened indifference to humane knowledge.

The quality of personal life, the strength of the Nation to establish its security and contribute to the peace and moral order of the world, and the character of the culture in its power to sustain a future of long and high achievement depend upon education more than anything else. The American people now must make a full commitment of their vast human and material resources to the purposes of education if they hope to guarantee the future. It must be a continuing commitment to science and engineering. But it must also be a commitment to the total life of the mind and spirit—to the writing and reading of great literature, to the cultivation of great philosophy, to the creation of great music and great poetry. The time is past when the Nation can afford to neglect some things that are important in favor of others that are important. The task of the schools now is to critically examine their purpose and their program. Education must not simply keep up with a fast-moving world. It must lead it and determine its direction.

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